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THESIS

UNITED STATES MARINE CORPS MILITARY OCCUPATIONAL SPECIALTY (MOS) ASSIGNMENT MODELING USING AUGMENTATION PROBABILITIES

by

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March, 1996

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Regardless of the model used, the expected number of augmentees does not vary appreciably from the historical averages. Not adhering to the quality spread policy in the past has not impacted augmentation probabilities greatly. Dividing the class into halves vice thirds provides approximately the same expected number of augmentees as the current policy and would give more officers from the top of the class one of the their top choices. The only other change to assignment policy which may be warranted is restricting assignment for several MOSs (MOS 4002-data processing, 7208-air defense, and 7210-air support) to assignment from the top third or half of the class.

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UNITED STATES MARINE CORPS MILITARY OCCUPATIONAL SPECIALTY (MOS) ASSIGNMENT MODELING USING AUGMENTATION PROBABILITIES

by

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Submitted in partial fulfillment
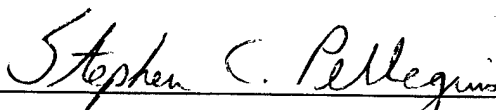of the requirements for the degree of

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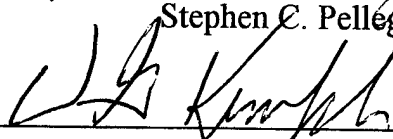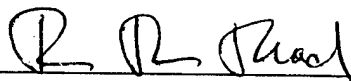## NAVAL POSTGRADUATE SCHOOL
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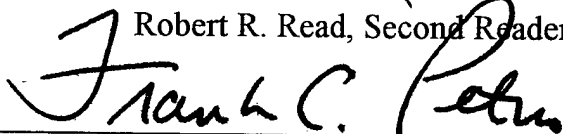
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ABSTRACT

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Regardless of the model used, the expected number of augmentees does not vary appreciably from the historical averages. Not adhering to the quality spread policy in the past has not impacted augmentation probabilities greatly. Dividing the class into halves vice thirds provides approximately the same expected number of augmentees as the current policy and would give more officers from the top of the class one of the their top choices. The only other change to assignment policy which may be warranted is restricting assignment for several MOSs (MOS 4002-data processing, 7208-air defense, and 7210-air support) to assignment from the top third or half of the class.

DISCLAIMER

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

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EXECUTIVE SUMMARY

All Marine officers begin their career at The Basic School (TBS), where, in addition to receiving training on the duties and responsibilities of a rifle platoon leader, officers are assigned their permanent Military Occupational Specialties (MOSs). This assignment is based on the officers' lineal class standing, TBS staff judgment, and the officers' preferences. Since 1977, due to the assignment of disproportionate numbers of officers from the top of the class to combat-arms MOSs and from the bottom of the class to non-combat arms MOSs, the class lineal list has been divided into thirds. One third of the quotas for each MOS were to have been filled by officers from each third of the class in order to achieve a "quality spread." Historically this process was not adhered to until 1993. More officers from the top of the class were given their choice and assigned to the combat-arms and more officers from the bottom of the class were assigned to the non-combat arms than was appropriate under the "quality spread" policy. It has been assumed that this has led to respective overages and shortages in these MOSs respectively in later years because the MOSs drawing the higher percentages of officer from the lower thirds have the lowest augmentation (from regular to reserve commission) and promotion opportunities.

To remedy these imbalances, strict compliance to the quality spread policy has been maintained since 1993. The needs of the Marine Corps are being given greater weight relative to the career desires of the officers than previously, in the belief that this will result in a more balanced Marine Corps in the years that follow.

This thesis focuses on augmentation to examine the effectiveness of this policy, and to compare it to two alternatives described below.

First, three augmentation functions are estimated for each MOS: the conditional probability of augmentation, given that the officer tries to augment; the probability that an officer will try to augment; and the unconditional probability of augmentation, each as a function of class standing. Results confirm that the better an officer performs at TBS, the better the chance of augmenting, given that he or she tries. Surprisingly though, for 12 of the 19 MOSs considered, the better an officer does at TBS, the less likely it is that he or she will try to augment. Together, these probabilities result in unconditional probabilities of augmentation less sensitive to class standing than might be expected.

Next, two assignment models were developed. The first (called the continuous model) does not partition the class. It attempts to give higher standing officers one of their MOS choices (favoring the higher choices) while meeting the needs of the Marine Corps through constraints on the expected augmentation percentages. The second (called the divisions model) mimics the current quality spread policy, except that the number of divisions can be selected.

The expected augmentation percentages, overall and by MOS, are used to compare and contrast four assignment policies: a policy implementing the continuous model with augmentation constrained evenly across all MOSs; a policy implementing the continuous model in which selected non-combat arms MOSs are constrained to higher percentages of augmentation; the current quality spread policy using the divisions model; and a milder quality spread policy that divides the class into halves.

Regardless of the model used, the expected number of augmentees did not vary appreciably from historical averages. Not adhering to the quality spread policy in the past has not impacted augmentation percentages greatly. The model which divided the list into halves vice thirds provided approximately the same expected number of augmentees as the current policy and would give more officers from the top of the class one of their top choices. The only other change to assignment policy which may be warranted based on expected augmentation percentages is restricting assignment for three MOSs (MOS 4002-data processing, 7208-air defense, and 7210-air support) to assignment from the top third or half of the class.

I. INTRODUCTION

A.   BACKGROUND

All Marine Second Lieutenants begin their career by attending The Basic School

(TBS) in Quantico, Va. The mission of The Basic School is:

> ... to educate newly commissioned officers in the high standards of professional
> knowledge, esprit de corps, and leadership traditional in the Marine Corps in
> order to prepare them for the duties of a company-grade officer in the Fleet
> Marine Force, with particular emphasis on the duties and responsibilities of
> a rifle platoon leader. [Ref. 1: p.260]

This mission is accomplished through an intensive schedule of classroom

instruction and field exercises. Officers are tested on most of the exercises and material

taught throughout the six month school. All of the events are graded objectively with the

exception of two leadership evaluations, in which each Lieutenant is given a grade

subjectively based upon his peers', platoon commander's, and company commander's

recommendations.

At the end of the second month, approximately one third of the way through the

course of instruction, the Lieutenants are ranked in accordance with the grades received

on the events taken so far. This overall ranking (lineal list), their preferences, and their

platoon commander's judgment are used to determine their future Military Occupational

Specialty (MOS). The Staff Platoon Commanders spend an afternoon manually creating a

recommendation for MOS assignments, which is then approved by the Commanding

Officer of TBS and Headquarters Marine Corps (HQMC).

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B.   QUALITY SPREAD

Prior to 1977, Lieutenants were assigned MOSs based on their lineal standing at TBS. Although other factors were taken into consideration, to include TBS staff input, class standing was the primary determining factor. In 1977, a policy was issued to divide the lineal list into thirds and assign Lieutenants MOSs based on their individual choices and relative position within their respective third. The intent was to achieve a "quality spread" across MOSs. Using this system, approximately one third of the quotas for each MOS would be filled by Lieutenants from the top, middle, and bottom thirds of the class. "Quality spread" is a Commandant of the Marine Corps approved policy which ensures that all MOSs "equally share in the quality of Lieutenants", and "Quality is determined by lineal standing [at TBS] at the time of MOS assignment". [Ref. 2]

If this policy had been adhered to, approximately one third of the individuals assigned to each MOS would come from the top, middle, and bottom thirds of the lineal list composite percentile score distribution.

Historical data indicates that this has not been the case. If an MOS were no more desirable than the others, we would expect to see a relatively uniform distribution of individuals assigned to it as in Figure 1; if an MOS were relatively more desirable , we would expect a distribution skewed to the right within each third of the lineal list as in Figure 2; and if it were relatively less desirable, we would expect a distribution skewed to the left within each third of the list as in Figure 3. Regardless of desirability, one third of the total number of individuals assigned to an MOS would fall within each third of the

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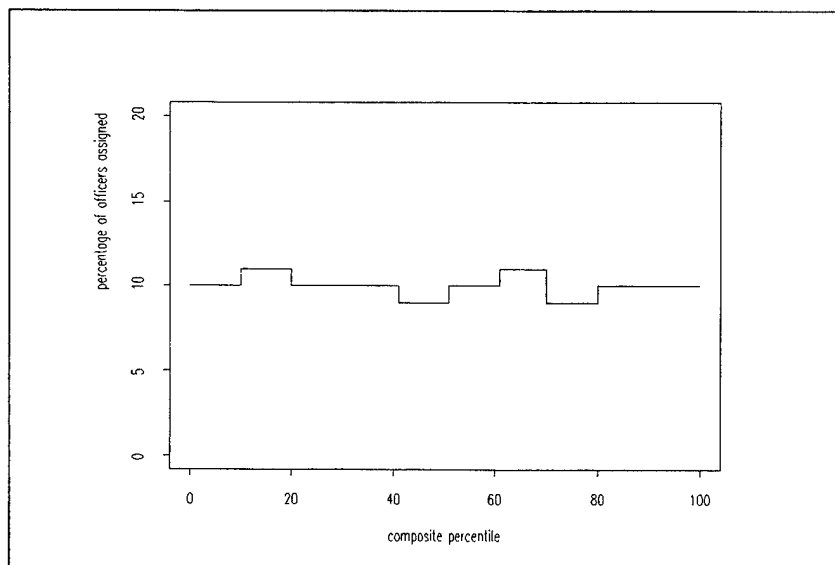
Figure 1. Hypothetical distribution of MOS assignments under current quality
spread policy with equal proportions of officers assigned from each third of the
lineal list.
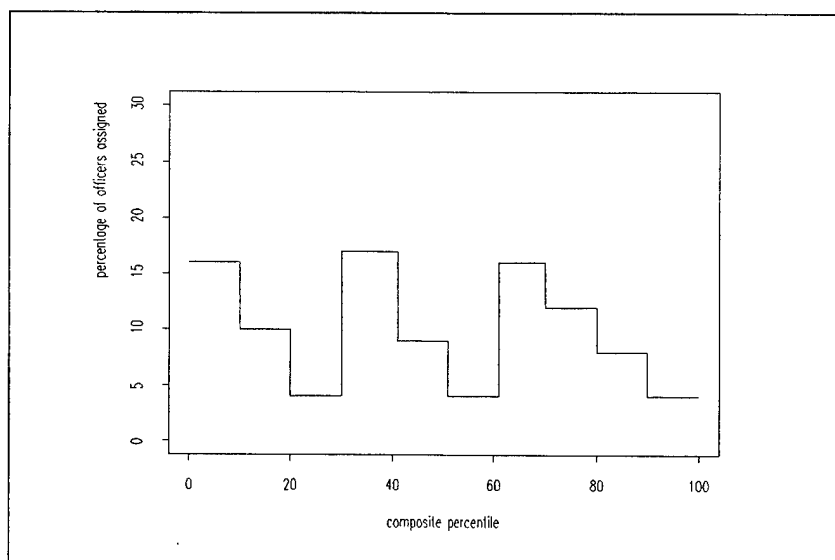
Figure 2. Hypothetical distribution for a relatively desirable MOS under current
quality spread policy. One third of the quotas for each MOS are assigned
to each third of the class, so those individuals at the top of each third are given
preference over those beneath them.
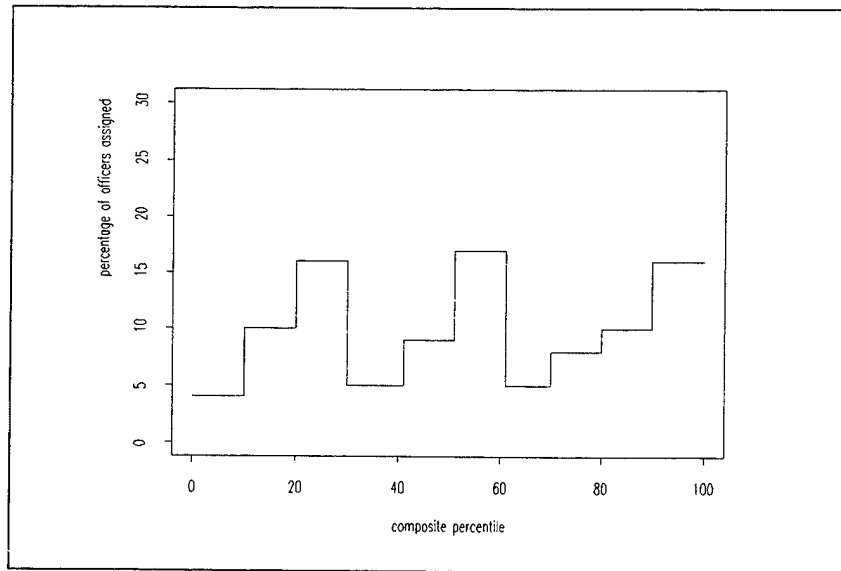
Figure 3. Hypothetical distribution for a relatively undesirable MOS under current quality spread policy. Those individuals at the bottom of each third of the class are assigned to the undesirable MOS.
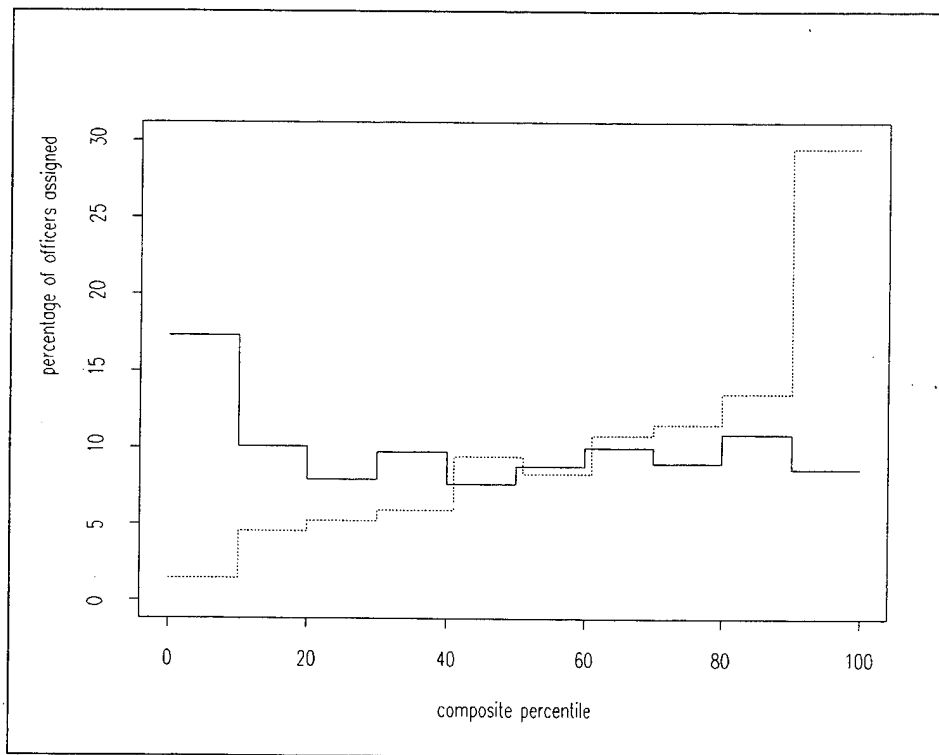
Figure 4. Empirical distributions of infantry officers (MOS 0302-solid line) and supply officers (MOS 3002-dashed line) for the period 1985 to 1991. Since infantry is the most stressed and advocated MOS at TBS, a bias existed towards assigning more high quality officers to the infantry than would be appropriate under the quality spread policy. Conversely, supply appears to have been assigned an inordinate number of officers from the bottom of the class (30% from the bottom 10%).

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lineal list. Figure 4 shows the empirical distribution for two MOSs, 0302 (infantry —
combat arms) and 3002 (supply — non-combat arms) for the period 1985 to 1991. It is
clear that the assignments have not been balanced between the three parts of the lineal list.
Empirical distributions for the remaining MOSs are given in Appendix A. A clear pattern
emerges: those MOSs that are more desirable, typically combat arms, are more likely to
skewed to the right (i.e., the tail is stretched to the right) over the entire lineal list, and
those MOS that are seen as less desirable, typically non-combat arms, are more likely to
be skewed to the left. This indicates that there has been a bias towards individual choice,
resulting in more individuals assigned to the combat-arms from the top of the class and
more to the non-combat arms from the bottom the class than would be appropriate under
the "quality spread" policy.

C.   PROBLEM

For the past several years, there has been shortage of senior company grade
(Captain) and field grade (Major and Lieutenant Colonel) officers in the non-combat arms
as typified by Appendix B, the most recent Marine Corps Bulletin 1210, which lists the
relative fill of each MOS as either balanced, short, or over. Current thinking within the
Marine Corps is that the inordinate percentage of officers assigned to the non-combat
arms from the bottom of the TBS classes has adversely impacted the probability of
augmentation[*] and promotion in these MOSs, later resulting in their having too few
officers.

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* Initially, Marine Corps officers are commissioned into either the "regular" Marine Corps or the Marine Corps Reserves. Membership in
the regular Marine Corps permits one to continue service until retirement, provided he or she is successfully promoted. With few
exceptions, a reserve officer who wishes to serve longer than the initial obligation must obtain a regular commission. The process of
applying for and receiving appointment into the regular Marine Corps is called "augmentation". The purpose of augmentation is to ensure
that an appropriate number of regular captains are ready for promotion to major every year. It is a highly competitive process.

The Commanding General, Marine Corps Combat Development Center

(MCCDC) wrote in Oct 89:

> At the root of this issue [MOS assignments] is how to best serve the needs of the Marine Corps while attempting to accommodate the individual preferences of our new lieutenants. ...With so many competing constraints facing the Marine Corps — to include fixing imbalanced MOSs — it is necessary and prudent to place Marine Corps needs at the forefront in resolving this issue. In that regard, a process to best match desires and aptitude to requirements should be our goal. [Ref. 3]

A position paper by MMOA-3 (HQMC Manpower) written in April 93 states that:

> Unless the policy of quality spread is adhered to, the Marine Corps will remain short in certain occupational fields....The effect of the practice at the Basic School [of not adhering to a quality spread] appears to be causing grade imbalances and population shortages in some MOSs as a result of the competitive nature of our augmentation and promotion opportunities....those fields drawing the higher percentage of lower thirds will continue to have the lowest augmentation and promotion opportunities. [Ref. 4]

The implication is that adhering to the quality spread policy would help bring up the numbers of company and field grade officers in those MOSs that are chronically short. The Marine Corps would like to increase the number of augmentees in these MOSs, since for an officer to be retained and continue to be promoted, he or she must first successfully augment. A positive correlation has been assumed between higher "quality" — lineal standing as based on composite score — and successful augmentation and promotion.

This thesis focuses on augmentation. First, three augmentation functions are estimated for each MOS: the conditional probability of augmentation, given that the officer tries to augment; the probability that an officer will try to augment; and the unconditional probability of augmentation, each as a function of class standing. Results confirm that the better an officer performs at TBS, the better the chance of augmenting,

given that he or she tries. However, the functional relationship is different for each MOS. For instance, for personnel officers (MOS 0180), there is very little change in the unconditional probability of augmenting regardless of lineal standing, while for data processing officers (MOS 4002) the unconditional probability falls off rapidly with lineal standing. It seems prudent to utilize this information during the assignment process in order to maximize the expected number of successful augmentees. For example, if personnel officers from the top or bottom of the class unconditionally augment at approximately the same rate, it may be more advantageous to assign personnel officers from the bottom of the class, or each third, to save the higher standing officers for those MOSs for which higher standing translates into a greater chance of augmentation.

Next, two assignment models are developed. The first (called the continuous model) does not partition the class. It attempts to give higher standing officers one of their MOS choices (favoring the higher choices) while meeting the needs of the Marine Corps through constraints on the expected augmentation percentages. The second (called the divisions model) mimics the current quality spread policy, except that the number of divisions can be selected.

The expected augmentation percentages, overall and by MOS, are used to compare and contrast four assignment policies: a policy implementing the continuous model with augmentation constrained evenly across all MOSs; a policy implementing the continuous model in which selected non-combat arms MOSs are constrained to higher percentages of augmentation; the current quality spread policy using the divisions model; and a milder quality spread policy that divides the class into halves.

D. OBJECTIVES

The primary objective of this thesis is to determine how a model that assigns MOSs in accordance with officers' choices and constrained by expected augmentation percentages will compare against a model of the current policy. A secondary objective is to determine the impact of reducing the number of divisions in the class from three to two. A by-product of the analysis will be a program that will duplicate the current manual assignment policy and could be used in the future if the current policy is continued.

II. DATA

The population analyzed consisted of Marine Corps officers attending the The Basic School from 1977 to 1991.

A.   DATABASE

The data was obtained from the Center for Naval Analysis (CNA). The database was merged by CNA from three sources: The Headquarters Master Files (HMF) provided historical and biographical information on each officer; TBS performance records provided the scores and lineal ranking; and Officer Retention Board (ORB) results told who was rejected and accepted for augmentation for those boards meeting in 1987 through 1993.

A SAS™ program (Appendix C) was used to extract the data required for this analysis from the database provided by CNA. The SAS™ program deleted those officers with unique MOSs which are not normally assigned at TBS such as aviators, lawyers, and military police. Only those officers who appeared to have had a "normal" career within a single MOS were considered. For example, those individuals who did not complete aviation training and were reassigned another MOS were not considered. All regular (as opposed to reserve) officers were also removed from consideration since they are not required to augment. The majority of those officers who successfully augment do so in their first attempt, which occurs approximately two years after TBS. Since the ORB results were provided for those boards meeting from 1987 to 1993, all officers attending TBS prior to 1985 were also not considered. Although many officers from year groups prior to 1985 successfully augmented after 1985, to include them would have meant

counting many other officers who successfully augmented prior to 1985 as never having augmented. This would have biased the estimated probabilities of augmentation.

The final sample consisted of 3,753 officers, from an initial population of 15,427.

B.   VARIABLES

The variables used for this analysis were MOS, augmentation results, and composite lineal ranking as a percentage. No distinction was made between successful augmentation on the first try and success after multiple attempts. If the officer successfully augmented at any time, then he or she was considered a success. Those officers who tried at least once and were never augmented were considered rejections. Those who never tried were considered as such.

The composite lineal ranking is actually calculated from the average of three other scores in the database: academic ranking; military skills ranking; and leadership ranking. The events that comprise each of these scores is listed in Appendix D. Since the composite lineal ranking is currently used in the assignment process it is used in this analysis as well. Another analysis has suggested that leadership alone may be a better indicator of future success [Ref 5]. Other options could therefor be to use leadership only, a weighted average of the three components, or the three components independently.

III. METHODOLOGY

The methodology employed in this thesis can be divided into three parts: 1.) the personnel and augmentation data was analyzed to determine unconditional and conditional probabilities of augmentation for each MOS; 2.) a PASCAL™ program was written to simulate Lieutenants choosing MOS's; and 3.) a GAMS™ assignment model was then written which used the augmentation probability data from 1.) above and several different choice tables generated with the program in 2.). These are discussed in the three sections that follow.

A.   DATA ANALYSIS

The data analysis began by using SAS™ to reduce the original database obtained from CNA as described in Chapter II. S-plus™ was then used to conduct a detailed analysis of the reduced data set. Key data elements were: to which one of three categories the officer belonged — successfully augmented, rejected, or never tried; the MOS the officer was assigned to; and the officer's composite lineal standing (expressed as a percentile). The composite percentile is interpreted as the lower the percentile, the higher the standing in the class. The top performers are therefor in the first percentile, while those at the very bottom of the class are in the hundredth percentile. Three probability functions were estimated; the conditional probability of augmentation, the probability that an officer would attempt to augment, and the unconditional probability of augmentation. The conditional probability of augmentation vs. composite lineal ranking percentage (Figure 5) describes the chances of successfully augmenting, given that an officer tries to

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conditional probability of augmenting

probability

composite lineal rank percentage
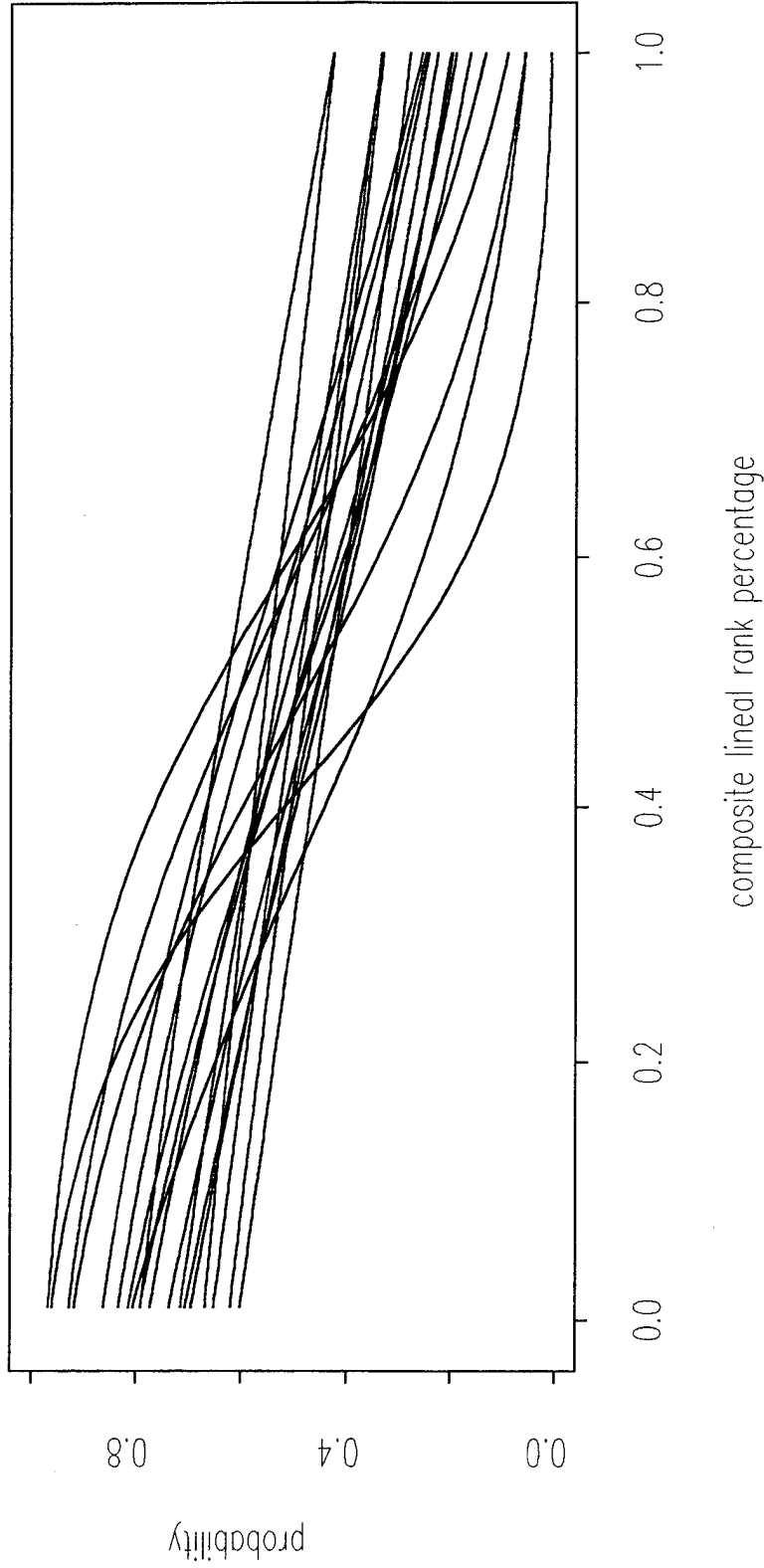
Figure 5. The conditional probability of augmentation describes the probability that an officer in a given MOS will successfully augment given that he or she tries as a function of composite lineal rank. Each curve represents a different MOS (19 total). Individual MOSs are shown in Appendix F. Probabilities range from approximately .60 to nearly 1 for top performers and from nearly 0 to approxiamately .50 for those at the bottom of the class.
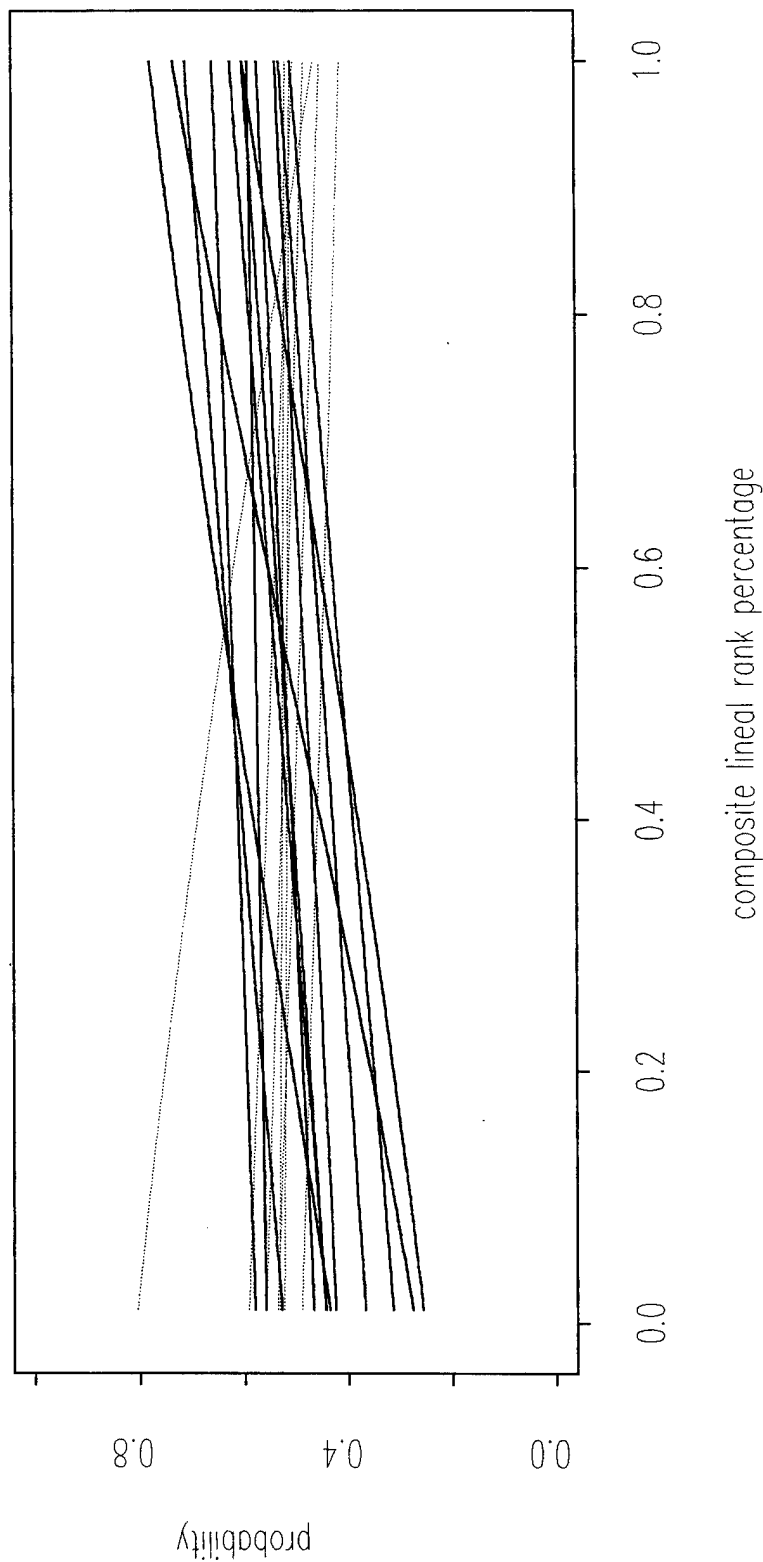
Figure 6. The probability that an officer will try to augment decreases with higher class standing (lower rank) for 12 MOSs and increases for seven MOSs. Each curve represents a different MOS. The seven MOSs with decreasing slope (MOSs 1802, 1803, 2502, 3002, 3402, 7208, and 7210) are represented by dashed lines. Individual MOSs are shown in Appendix G. The predominant trend is for better performing officers to have a lower probability of trying to augment.

unconditional probability of augmenting
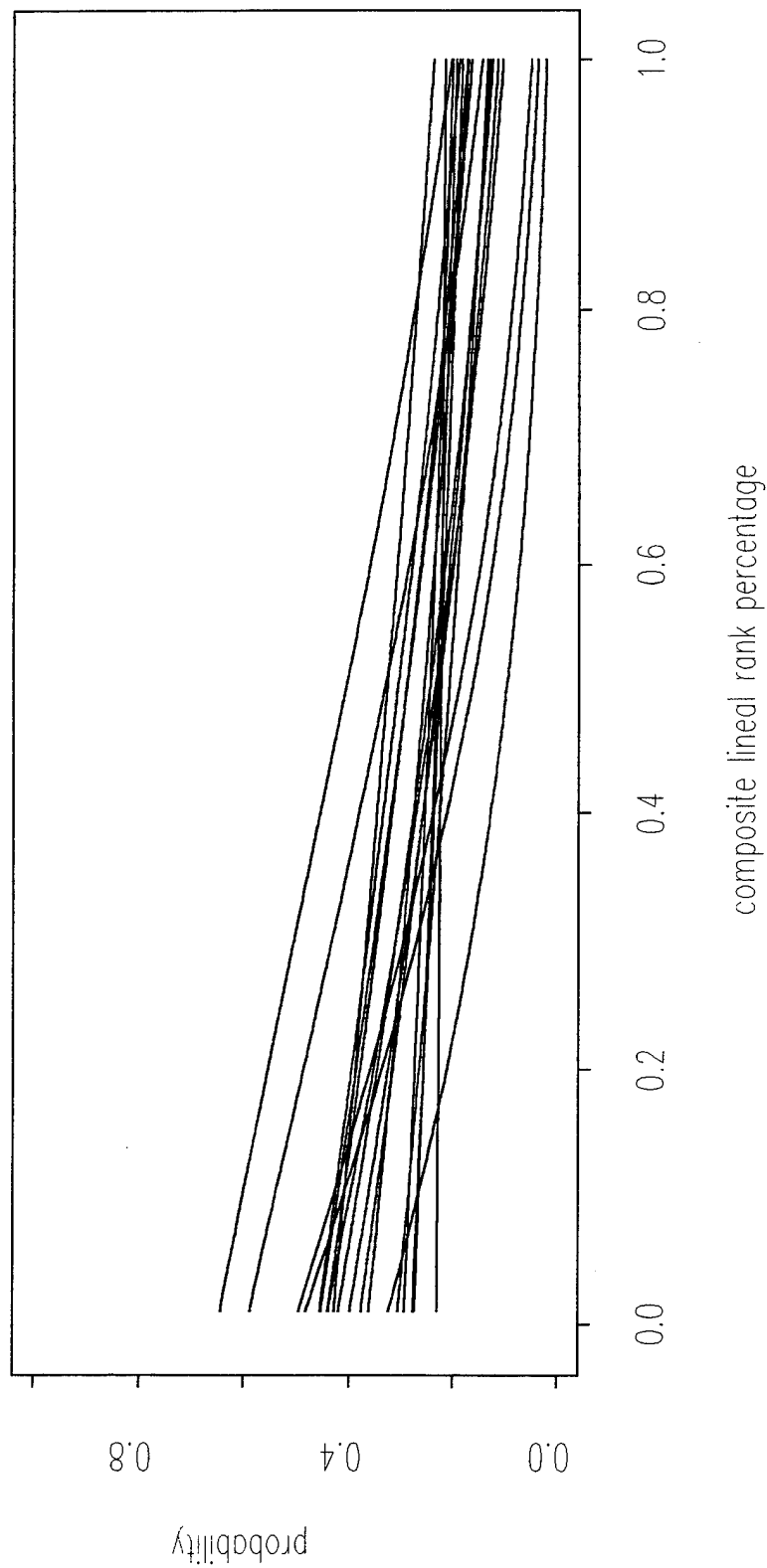
Figure 7. The unconditional probability that an officer will successfully augment increases with higher class standing (lower rank) for all 19 MOSs. Each curve represents a different MOS. Individual MOSs are shown in Appendix H. The effect of higher class standing is not as strong as anticipated due to the surprising negative effect of class standing on trying to augment (Figure 6).

augment. As would be expected, the better an officer does at TBS, the more likely their chances of augmenting, given that they try. The probability that an officer in a given percentile would attempt to augment (Figure 6) was also estimated. Surprisingly, the probability that an officer tries to augment decreases with increasing performance at TBS in twelve of the nineteen MOSs. The best performers at TBS are not as likely to attempt to augment as others. Within an MOS, for a given composite lineal rank percentile, this probability multiplied by the former conditional probability of augmenting given that the officer tries, equals the unconditional probability of augmentation (Figure 7). The better an officer does at TBS, the better the chance that they will augment, though not as much as the conditional probabilities shown in Figure 5 would have led us to believe, due to the often decreasing probability that better performers at TBS will try to augment. While the conditional probability is the most important from each individual's perspective, the unconditional probability is what is important from the Marine Corps' perspective and is used in the assignment model.

The goal of this phase of the analysis was to develop a model or models that, given an officer's composite lineal ranking percentile and MOS, will give the estimated probability that the officer will successfully augment. For convenience, a separate model of the relationship between composite score and probability of successful augmentation was developed for each MOS. This was done in two ways: first, models were developed that give the conditional probability of successful augmentation given that the officer tries and the probability that the officer tries for each percentile; second, a model was developed that gives the unconditional probability of successful augmentation for each

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percentile. The latter model could be obtained from the preceding two, but with the power of modern computers, it was easier to fit it directly.

For each of these relationships, the observed responses are binary (e.g., success or failure to augment, and try or not try to augment). Each is assumed to be a realization of a Bernoulli random variable with unknown parameter p, which is a function of composite score. The models were developed using the generalized linear model function (glm) in S-Plus^{TM}. This function models the logit (the log of the odds ratio) of the probability of success as a linear function of the composite score,

$$\text{logit}(p_i) = \ln [p_i / (1-p_i)] = \beta_o + \beta_1 x_i$$

where p_i is the probability of augmentation of individual i and x_i is the composite percentile score for individual i. The fitted relationship is then inverted to give the estimated probability of success as a function of composite score,

$$\hat{p}_i = \frac{\exp(\hat{\beta}_o + \hat{\beta}_1 x_i)}{1 + \exp(\hat{\beta}_o + \hat{\beta}_1 x_i)}$$

The results of the logistic regressions for each MOS can be found in Appendix E.

B. PREFERENCE SIMULATION

As stated by the Commanding General MCCDC earlier, lieutenant's preferences should be considered as well as the Marine Corps' needs when assigning MOSs. A PASCAL^{TM} program (Appendix I) was written to simulate student preferences. The MOSs were grouped into five similar groups; combat arms, support, service support, administrative, and air defense. The first and second choices were randomly chosen from the same group. The third choice was randomly chosen with the caveat that if the first two had come from the combat arms group, the third could not. This criterion mirrored the

requirement at TBS that lieutenants must include at least one non-combat arms choice in their top three choices. The program was used to create three different preference distributions. In the "best case," distribution "A," the distribution of preferences matched the historical distribution of requirements as determined from the sample data set. In the "worst case," distribution "C," all officers picked combat arms for their first and second choices and the third choice was uniformly distributed among the remaining non-combat arms MOSs. An intermediate choice distribution, distribution "B," was created as an average of the "best" and "worse" cases. In each case the officers' preferences are reflected by "choice points" assigned to the chosen MOSs. The first choice was assigned a value of three, the second choice two, and the third choice one.

C.   ASSIGNMENT MODELS

Every officer student at TBS must be assigned to an MOS. Two assignment models were created using GAMS™ (Appendix J and K). Both models maximize a weighted sum of the choice points resulting from students receiving an MOS of their choosing while considering some kind of quality spread. The first model, the "continuous" model, uses the estimated unconditional augmentation probabilities to ensure a quality spread where it matters — in future augmentation. No constraints are placed on having a particular proportion of the officers come from any kind of divisions (e.g., thirds). The second model mirrors the current assignment policy with the quality spread effected by a division into thirds. Approximately one third of the officers assigned to any given MOS will come from each third of the class.

1. "Continuous" model

The continuous model is written below in Naval Postgraduate School format.
Comments to explain the model follow.

INDICES:

m MOS $m = 1,..M$

p person $p = 1,..P$

per percentile $per = 1,.. PER$

pref preference $pref = 1,.. PREF$

INDEX SET:

$\Omega_{p,per}$ = {p: person p belongs to percentile per}

DATA:

$reqd_m$ required number of MOS m

$\underline{aug}_m$ lower bound for percentage of augmentees from MOS m

$phat_{m,per}$ probability of individual in percentile per augmenting if assigned MOS m

$cp_{m,p}$ choice points for MOS m for individual p

BINARY DECISION VARIABLE:

$x_{m,p}$ equals 1 if person p is assigned MOS m

FORMULATION:

Maximize: $\sum_{m,p} cp_{m,p} * x_{m,p} * (P+1-p) + \sum_{m,p} (x_{m,p} \sum_{\Omega_{p,per}} phat_{m,per})$

Subject to:

(1) $\sum_p x_{m,p} = reqd_m$ $\forall\ m$

(2) $\sum_m x_{m,p} = 1$ $\forall\ p$

(3) $\sum_p (x_{m,p} \sum_{\Omega_{p,per}} phat_{m,per}) = reqd_m * \underline{aug}_m$ $\forall\ m$

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The indices used are *m, p, per,* and *pref.* The nineteen MOSs are represented by *m.* Each officer is denoted by *p.* The *p*'s are ranked in a lineal list in order of decreasing performance. Individual composite percentiles are represented by *per.* An officer's preference for first, second and third choice of MOS is represented by *pref.*

The required number of officers to be assigned to each MOS is contained in reqd_m. In the model runs, the numbers used were the historical proportions of each MOS assigned from the entire data set. The required percentage of MOS m to augment is represented by $\underline{\text{aug}}_m$. The probability of an individual from percentile *per* augmenting is given by $\text{phat}_{m,per}$. The number of "choice points", three, two, or one for the first, second, and third choice respectively, for individual *p* for MOS *m* is given by $\text{cp}_{m,p}$.

The only decision variable is a binary variable $x_{m,p}$ which is 1 if individual *p* is assigned MOS *m* and 0 if not.

The objective function maximizes a combination of weighted "choice points" and the expected number of future augmentees. The choice points are weighted by an officers' reversed lineal standing so that a better performing officer is more likely to receive his or her choice. For example, assigning the top student their first choice results in an increase of the objective function's value of 300=100(reverse lineal standing)*3(choice points for first choice). Assigning the same officer their second choice increases the objective by 200=100*2(choice points for second choice), while assigning an officer from the middle of the class their third choice would result in an increase of 50= 50(lineal standing) * 1 (choice points for third choice). The complete objective function is comprised of the preceding choice points contribution, plus the expected number of augmentees resulting

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from the assignments. The expected number of augmentees is small relative to the total of the weighted choice points and is used as a tie-breaker to best assign those individuals who do not receive any of their top three choices. These officers will be assigned an MOS to which they gave zero choice points and would otherwise contribute nothing to objective function.

The first constraint ensures that the MOS requirements are fulfilled. The second constraint ensures that each individual is only assigned a single MOS. The last constraint ensures that the expected percentage of augmentees from each MOS is equal or greater to the amount specified.

2. Divisions Model

The divisions model mirrors the current policy. It is very similar to the above model except that it does not take augmentation data into account, and has "quality spread" constraints. The divisions model is written below in Naval Postgraduate School format. Comments to explain the model follow.

INDICES:

m	MOS	$m = 1,..M$
p	person	$p = 1,..P$
per	percentile	$per = 1,.. PER$
pref	preference	$pref = 1,..PREF$
d	division	$d = 1,..D$

INDEX SET:

$\Omega_{p,d}$ = {p: person p belongs to division d}

DATA:

$reqd_m$ required number of MOS m

$cp_{m,p}$ choice points for MOS m for individual p

BINARY DECISION VARIABLE:

$x_{m,p}$ equals 1 if person p is assigned MOS m

FORMULATION:

Maximize $\Sigma_{m,p}\ cp_{m,p} * x_{m,p} * (P+1-p)$

subject to

(1) $\Sigma_p\ x_{m,p} = reqd_m$ $\forall\ m$

(2) $\Sigma_m\ x_{m,p} = 1$ $\forall\ p$

(3) $\Sigma_{\Omega_{p,d}}\ x_{m,p} > trunc(reqd_m / D + .9)$ $\forall\ m,d$

The indices are the same except for the addition of the division into D pieces (where D equals three for thirds and two for halves). The data and formulation of the objective function and first two constraints are the same except for the absence of augmentation data. The quality spread is ensured by the third and fourth constraints in which equal proportions of each MOS quota must be assigned to each division.

3. Program Execution

Each of the models (continuous, divisions) was run in two separate forms. The continuous model was run with two different sets of minimum required augmentation percentages. In the first run of the continuous model, all MOSs were constrained to have at least 20% augmentation. In the second run, some of the non-combat arms MOSs (personnel, intelligence, logistics, supply, air support, and air defense) were constrained to higher levels (23, 29, 25, 29, 25 and 28% respectively). The divisions model was also run

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with two variations. One run was with three divisions (reflecting the current policy) and another with only two divisions. Each of the four previous variations was run 90 times: 30 times drawing choice tables from distribution A, 30 times with tables from distribution B, and 30 times with tables form distribution C. Therefore, the following results were obtained from a total of 360 program runs. Commands were included in the GAMS codes of the above programs to output the expected number of augmentees for each MOS and the number of individuals receiving their first, second and third choices for each run.

The continuous model was also run to determine two bounds. First, the choice point variables were removed from the objective function so that the model maximized the total expected number of augmentees only. This resulted in an overall expected augmentation percentage of 29% compared to the overall empirical augmentation percentage of 27%. Second, each of the required augmentation percentage constraints was increased incrementally to determine the greatest augmentation percentage where all MOSs would be equal. MOS 0180 (personnel) can not be increased beyond 23% as that is the unconditional augmentation probability for someone at the top of the class. Allowing the other MOSs to increase while keeping MOS 0180 at 23% resulted in a maximum even level of 26%, the greatest percentage for which all MOSs will augment equally, except for MOS 0180. The absolute upper bound for any individual MOS is the unconditional probability of augmentation for the first percentile as shown on Figure 7.

IV. RESULTS

A.   POPULATION

Individually, some of the slope parameters for the unconditional logistic regressions would not be considered significantly different from zero. A logistic regression with a zero slope parameter would indicate that the unconditional probability of augmentation was independent of lineal ranking. The t-statistics are less than 1.64 (the value required for a 2-tailed test at 90% confidence) for 7 of the 19 MOSs (0180, 0202, 0402, 2602, 3060, 3502 and 6002) and less than 1.96 (the value required for a two-tailed test at 95% confidence) for 8 (MOS 1802 in addition to preceding MOSs). But, taken together, all 19 have slopes less than zero, which has a probability less than 0.00001 under the null hypothesis that all slopes are zero. Consequently, we conclude that lineal rank does effect the unconditional probability of augmentation and use the fitted functions to obtain parameters for all MOSs for the assignment models. This is supported by Figure 7.

As shown by Figure 6, the most surprising result was the common likelihood that increasing performance was not positively correlated with the probability that an officer would attempt to augment.

As shown by Figure 7, three MOSs appear to be more severely impacted by assigning officers from the bottom half of the class than any others; MOSs 4002-data processing, 7208-air support and 7210-air defense.

B. ASSIGNMENT MODEL

1. Expected Number of Augmentees vs. Choice Distribution

Each assignment model maximizes the sum of the product of the "choice points" an officer gives an MOS and his lineal ranking (with the top person given a value of 100) and the contribution of this assignment to the expected number of augmentees. Thus, each individual is weighted so that the better performers will receive their choices before others, all other things being equal and ties will be broken to increase the expected number of augmentees. The three choice distributions under consideration are described in Chapter III. As more individuals desire the combat arms, the expected number of augmentees from the combat arms increases, since the program has more officers to choose from and picks the best officers possible consistent with their choices. The number of expected augmentees from the non-combat arms decreases or stays relatively constant depending on the number of billets required within each MOS. If there are only one or two billets being filled, then the assignments do not change much from distribution to distribution.

2. Expected Number of Augmentees vs. Model Type

The expected proportion of augmentees for each MOS is shown on Figures 8, 9, 10 and 11. Boxplots graphically show several attributes of the data. The white bar inside the "box" represents the median. The solid box extends above and below the median enough to encompass 25% of the data on either side, called the interquartile range (IQR). The dotted lines, or whiskers, extend above and below the box enough to encompass any points within a range of 1.5 * IQR. Short horizontal lines may extend above and below the whiskers to show any points outside of the range encompassed by the whiskers, called

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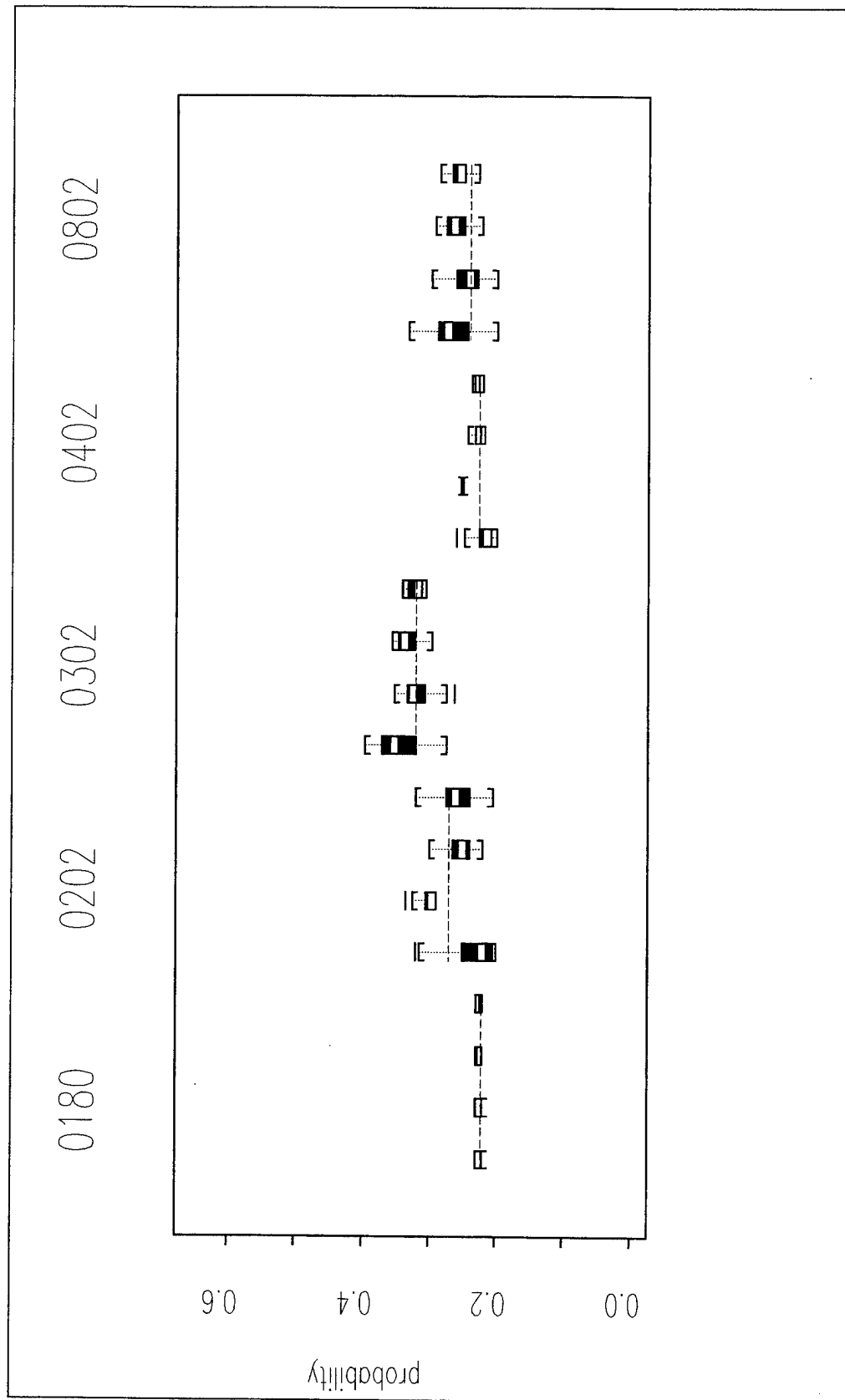
Figure 8. Expected proportion of officers augmenting from MOSs 0180, 0202, 0302, 0402, and 0802. The results of each of the four models are connected by a dashed line located beneath each MOS. The first box of each group contains the results from the continuous model with each MOS constrained to at least 20% augmentation. The second box contains the results when certain non-combat arms MOSs are constrained to higher percentages. The third box contains the results of the divisions model operating with halves and the last box is the division model operating with thirds (reflecting the current policy).

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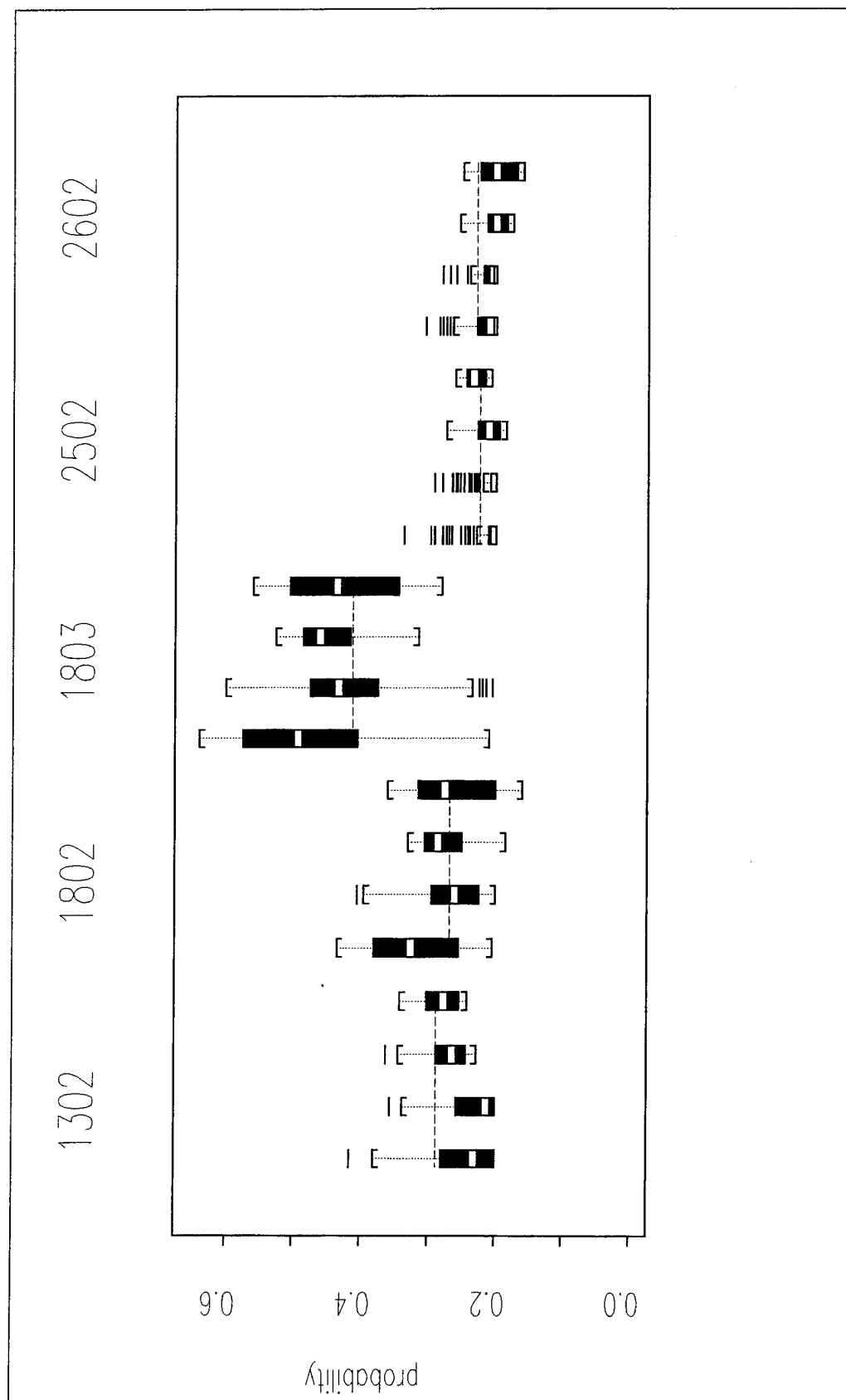
Figure 9. Expected proportion of officers augmenting from MOSs 1302, 1802, 1803, 2502, and 2602. The results of each of the four models are connected by a dashed line located beneath each MOS. The first box of each group contains the results from the continuous model with each MOS constrained to at least 20% augmentation. The second box contains the results when certain non-combat arms MOSs are constrained to higher percentages. The third box contains the results of the divisions model operating with halves and the last box is the division model operating with thirds (reflecting the current policy).
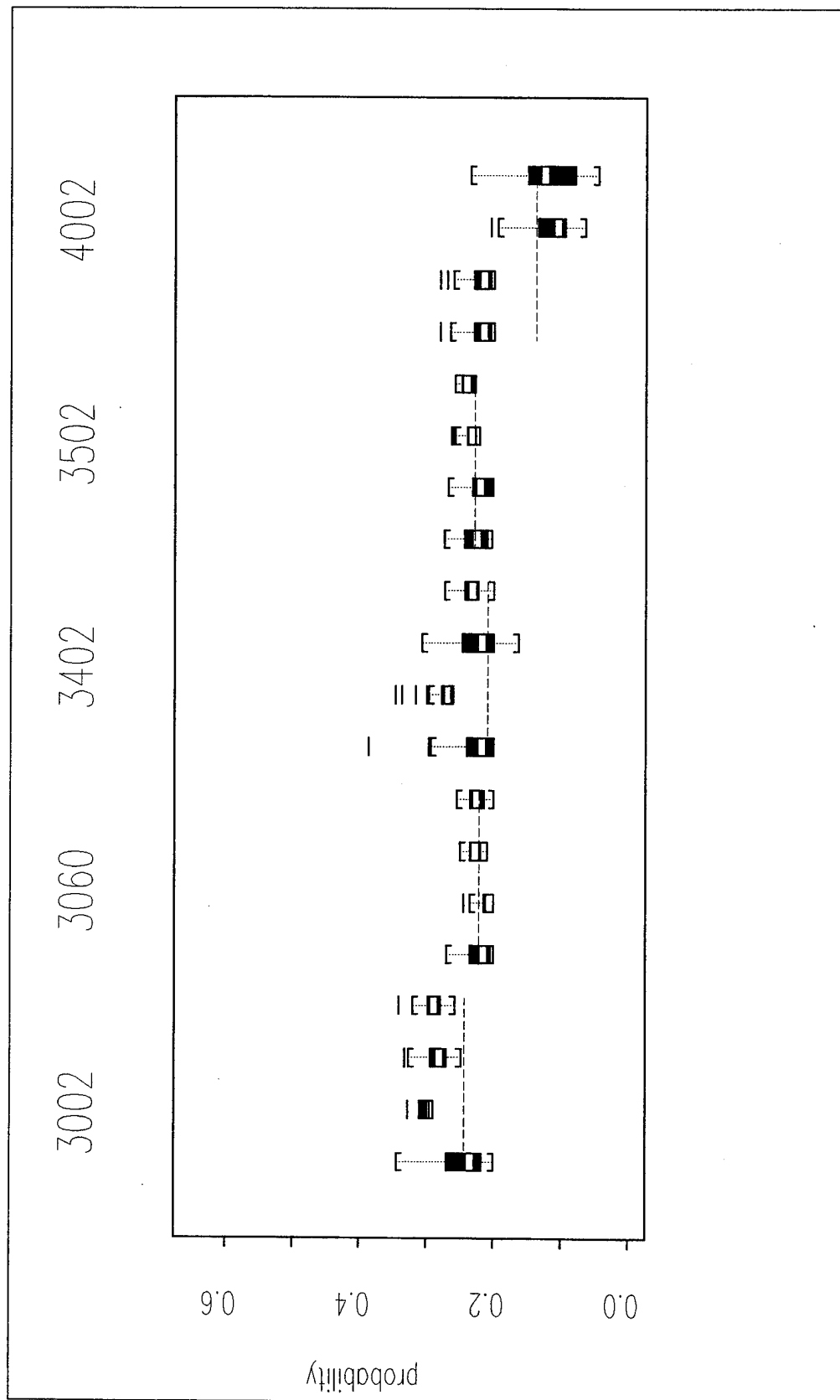
Figure 10. Expected proportion of officers augmenting from MOSs 3002, 3060, 3402, 3502, and 4002. The results of each of the four models are connected by a dashed line located beneath each MOS. The first box of each group contains the results from the continuous model with each MOS constrained to at least 20% augmentation. The second box contains the results when certain non-combat arms MOSs are constrained to higher percentages. The third box contains the results of the divisions model operating with halves and the last box is the division model operating with thirds (reflecting the current policy).
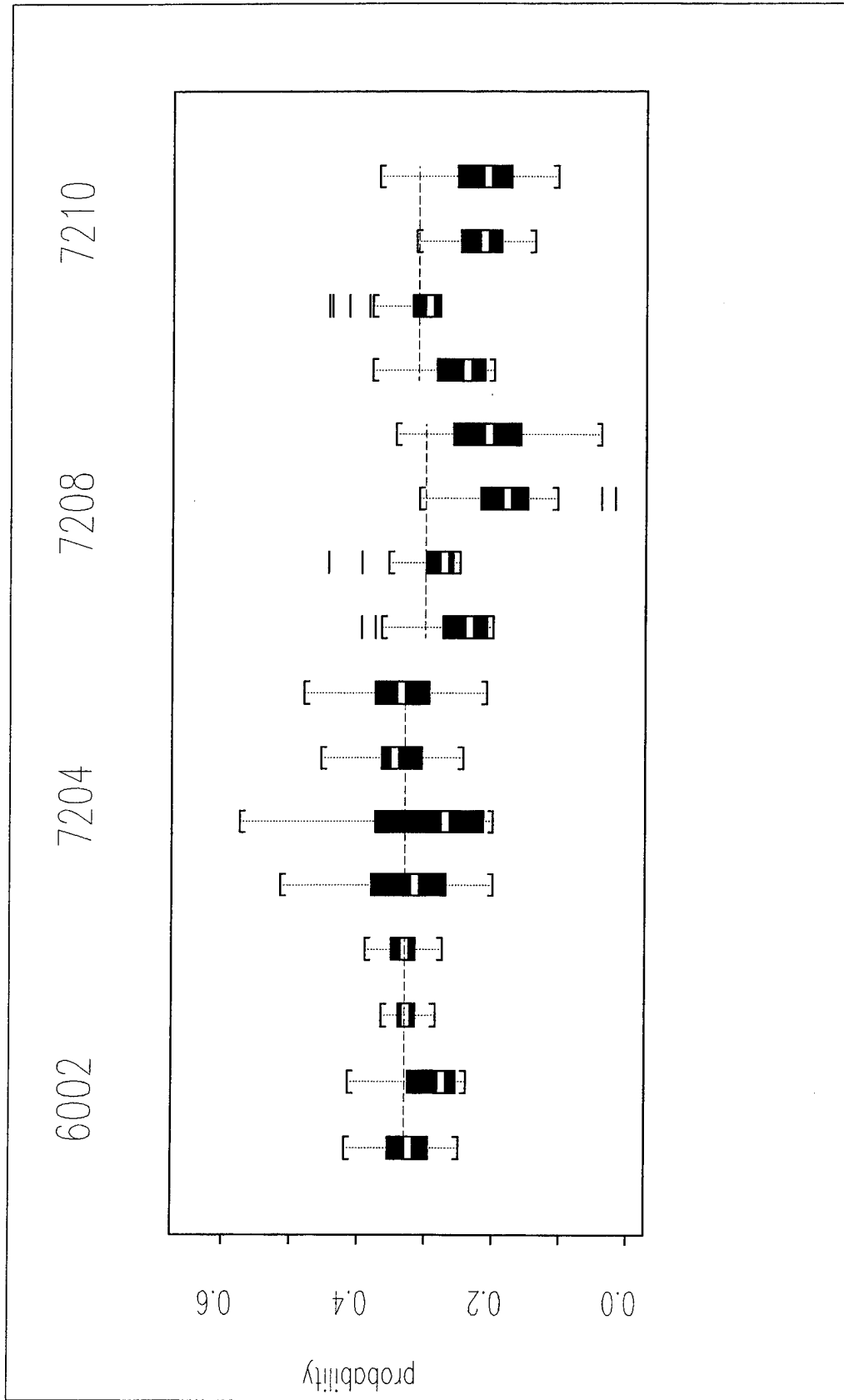
Figure 11. Expected proportion of officers augmenting from MOSs 6002, 7204, 7208, and 7210. The results of each of the four models are connected by a dashed line located beneath each MOS. The first box of each group contains the results from the continuous model with each MOS constrained to at least 20% augmentation. The second box contains the results when certain non-combat arms MOSs are constrained to higher percentages. The third box contains the results of the divisions model operating with halves and the last box is the division model operating with thirds (reflecting the current policy).

outliers. Each boxplot contains all the results for a given model over each of the three choice distributions (i.e., 90 data points). Each MOS has four boxplots beneath it, one for each of the four models: (1) continuous with all MOSs constrained to at least 20% augmentation; (2) continuous with selected MOSs constrained to higher augmentation percentages; (3) division into halves; and (4) division into thirds. The boxplots for each MOS are connected by a horizontal line which represents the empirical augmentation proportion for that MOS from the sample from 1985 to 1991.

The first continuous model maintains or exacerbates the shortages and overages identified in Appendix B with one notable exception (see below). Since the model maximizes the number of high standing officers receiving their top choices, which are biased towards the combat-arms, the expected number of augmentees from these MOSs will increase while the number of augmentees from non-combat arms will decrease, though constrained to be at least 20 %. Data processing (MOS 4002) was the only MOS to have an empirical unconditional augmentation percentage of less than 20% and its percentage was therefore increased from its historical value of 14% to at least the constraint of 20%.

As shown by the figures, the second continuous model ameliorates the shortages and overages somewhat. Obviously, if some MOSs are constrained to meet certain goals, these goals will be met, so long as there is a feasible solution. Those MOSs specially constrained are increased, with a subsequent decrease in most other MOSs.

The division-halves and division-thirds models (the third and fourth boxplots respectively) demonstrate considerable similarity, and therefore frequently overlap. Eight of the nineteen MOSs remain within approximately 2% of the empirical augmentation

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percentages (MOSs 0180, 0302, 0402, 1802, 2502, 3060, 3502, and 6002). The remaining MOSs vary according to their likely "choice point" distribution. This can be offset, however, by the required number of billets. Those MOS more likely to be first and second choices (combat arms) are maximized within the divisions and have slightly higher percentages. Those MOSs which have less than three quotas will have no assignments from one or two of the thirds, most likely the top third if the MOS is considered as "undesirable," given the structure of the objective function.

C. LIMITATIONS

As can be seen in Appendix A (empirical distributions of officers assigned to each MOS), several of the logistic regressions were done with sample sizes of less than one hundred with little or no data over some of the portions of the distribution. Though the trends present would most likely remain unchanged, more officers could be included if more ORB results were used. The danger in using aged data, however, is that we are trying to predict future augmentation using historical data, predictions which cannot avoid being outside of the range (relative to time) of the data. The older the data, the more doubtful its relevance.

As discussed in Chapter II, officers attending TBS prior to 1985 were not considered in this analysis since although many officers from year groups prior to 1985 successfully augmented after 1985, to include them would have meant including many other officers who successfully augmented prior to 1985 as never having augmented. This would have biased the probabilities of augmentation. There is no effective way to eliminate this problem short of having the information for every officer and every

augmentation board. Without this knowledge, any splitting scheme will either include officers who successfully augmented in a prior board (the results of which are not known) as not having augmented, or will decrease the sample size and exclude officers who successfully augmented in a ORB that is recorded, though they were deleted due to their year group.

The actual distribution of officers' preferences for MOSs was not known. Any data currently available on the lieutenants' choices may be suspect regardless, since there has often been an element of "gaming" involved in the MOS selection process, with the officers "choosing" an MOS after having been told what is realistically available given his class standing. All of the assignment models maximize the number of officers receiving one their top choices. The three choice distributions described on page 16 ("A", "B" and "C") were created in such as way as to most likely encompass the actual desires of lieutenants based on the author's personal experience of the process and discussions with other officers.

V. CONCLUSIONS AND RECOMMENDATIONS

A.   CONCLUSIONS

Assigning MOSs based on augmentation probability will not significantly increase the expected number of augmentees from short MOSs.

As demonstrated by Figures 8 through 11, not adhering to the current quality spread policy in the past does not appear to have severely impacted augmentation probabilities for any MOS, including those identified as chronically short by Appendix B. Probabilities of augmentation do not appear to be the root of the problem for future imbalances.

B.   RECOMMENDATIONS

The results of this analysis do not warrant a recommendation to change the current policy of assigning MOSs through a quality spread effected by divisions. Given the similarity of the halves and thirds models discussed previously, a division into halves instead of thirds appears to achieve approximately the same "quality spread" while giving slightly more weight to individual preferences. Although Appendix A demonstrates that the current policy had not been adhered to prior to 1991, current assignments are being closely monitored and policy is being followed. Even so, this may not solve problem of the chronic imbalances typified by Appendix B. Other factors should be looked at, as is discussed in section C below.

The model developed to mirror the current policy can be used as a starting point for future assignments. Other constraints such as assigning women and trying to maximize

the minority representation in the combat arms could easily be included. The staff of TBS could then reassign those officers whom they choose.

Those MOSs that have been identified previously as being adversely sensitive to assignment from the bottom half (4002, 7208, 7210) often have only a few quotas per class. These billets should be assigned from the first third to avoid the negative impact of assignment from the bottom of the class.

C.   RECOMMENDATIONS FOR FURTHER STUDY

After successful augmentation, an officer must choose to remain in service and be promoted to be available. Since the probability of augmentation in the non-combat arms does not appear to be the problem, it would be prudent to investigate the data for retention and promotion to major for possible causes of the imbalances typified by Appendix B.

Other variables can be added to the generalized linear model in addition to composite lineal ranking such as race, gender, college background, commissioning source, etc., or the components of the combined composite score could be included separately.

A more accurate distribution of officer preferences could be obtained through surveys. Officers may also be given the option of choosing more than three MOSs or possibly be given a total number of "choice points" to assign to various MOSs.

MOS 0202-intelligence

MOS 0402-logistics

MOS 0180-personnel

MOS 0302-infantry
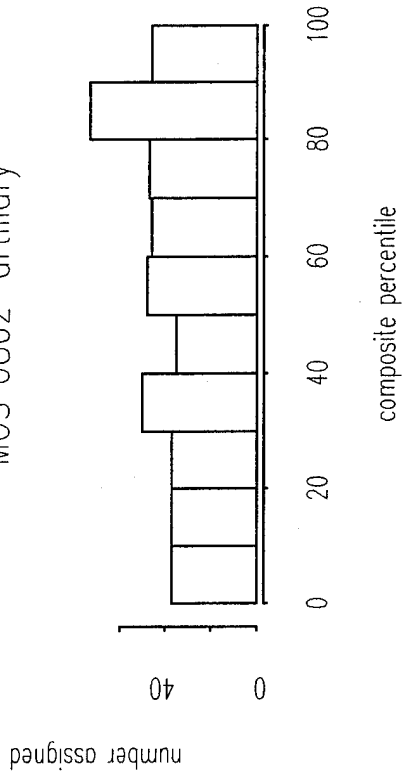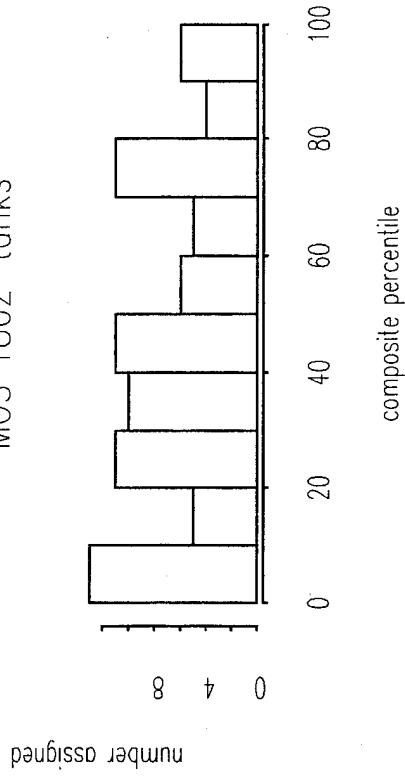
MOS 1302—enginneer

MOS 1803—AAVs

MOS 0802—artillary

MOS 1802—tanks
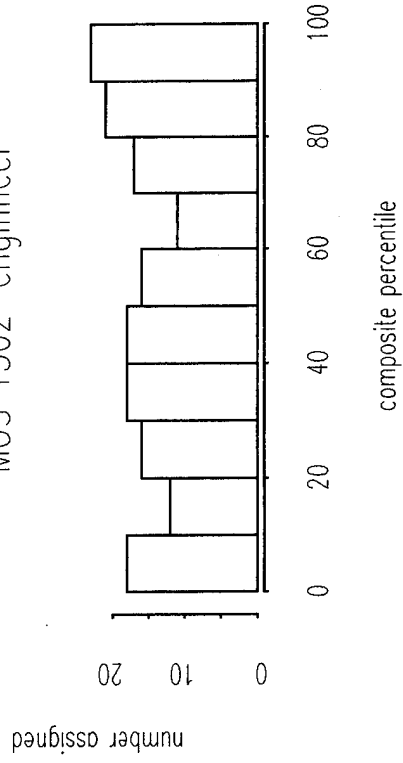
MOS 2602–signals intelligence

MOS 2502–communications
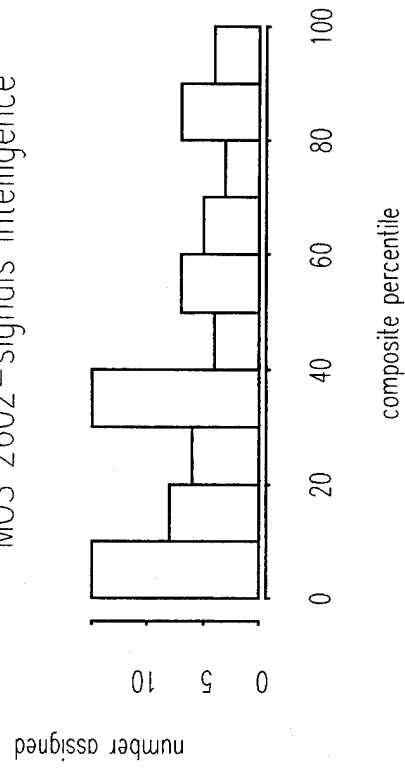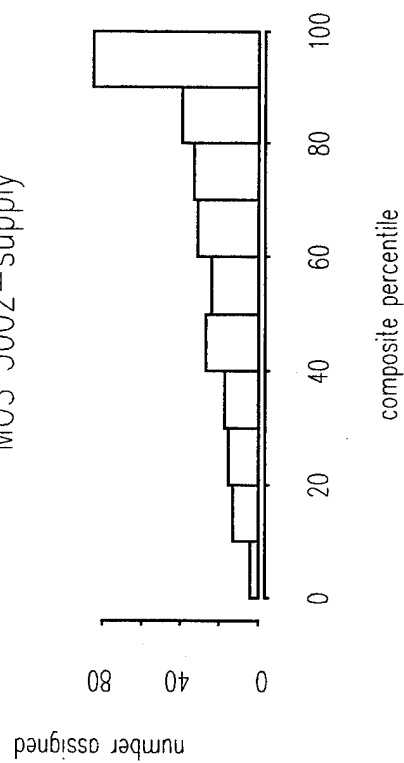
MOS 3060–aviation supply

MOS 3002–supply
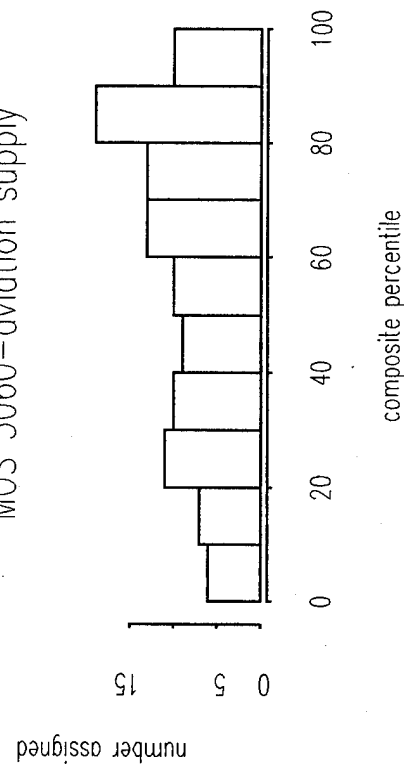
MOS 3502-motor transport

number assigned

composite percentile

MOS 3402-disbursing

number assigned

composite percentile
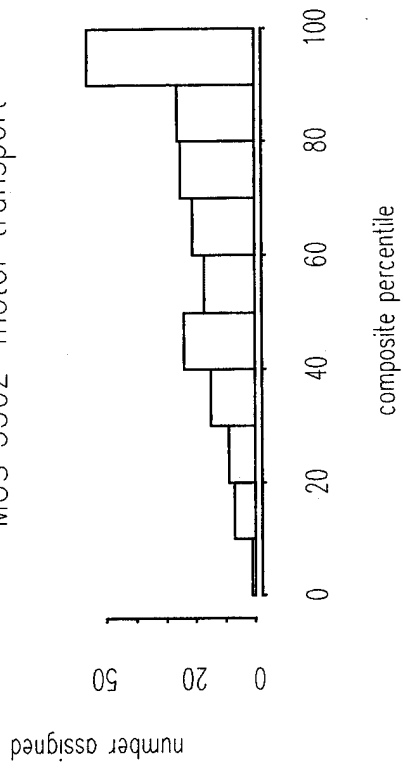
MOS 6002-aviation maintenance

number assigned

composite percentile

MOS 4002-data processing

number assigned

composite percentile
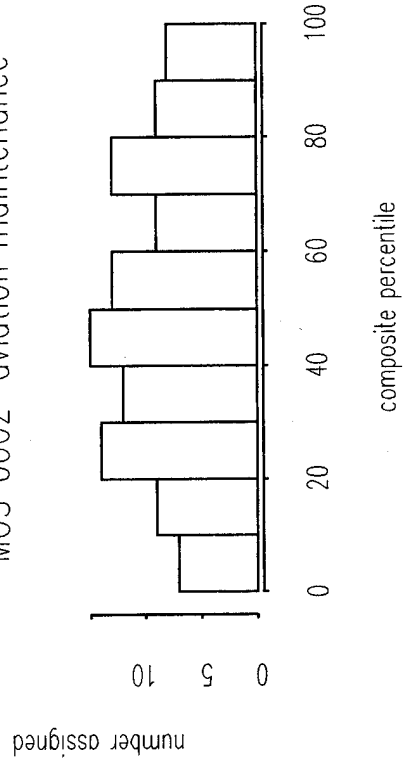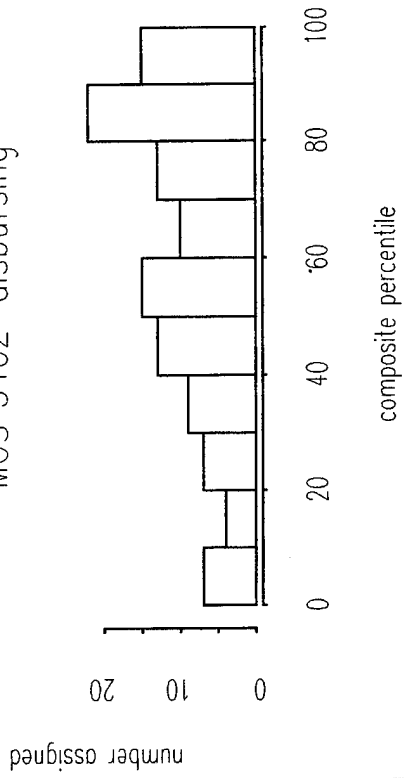
MOS 7208-air support

MOS 7204-anti-air warfare

MOS 7210-air defense
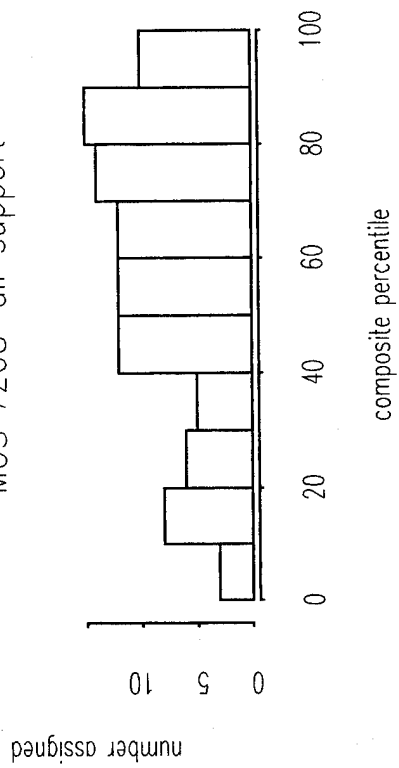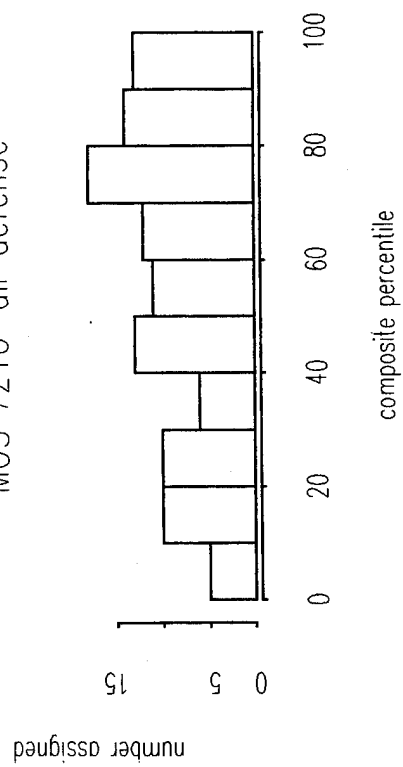
APPENDIX B

ADMINISTRATIVE MESSAGE

ROUTINE

R 261200Z OCT 95 ZYB

FM CMC WASHINGTON DC//MPP//

TO ALMAR

UNCLAS //N01210//
ALMAR 349/95

MSGID/GENADMIN/MPP-32//

SUBJ/MCBUL 1210 LATERAL MOVE PROGRAM FOR MARINE OFFICERS//

REF/A/DOC/MCO 1210.8A/21SEP82//

AMPN/LATERAL MOVE AND CAREER BROADENING TOUR PROGRAMS FOR MARINE OFFICERS//

RMKS/1. THE REF ESTABLISHES A LATERAL MOVE PROGRAM FOR MARINE OFFICERS. THIS BULLETIN PUBLISHES THE STATUS OF THE GROUND UNRESTRICTED OFFICER MOS. OFFICERS MAY APPLY AT ANY TIME FOR A LATERAL MOVE OR CAREER BROADENING TOUR IF THEY MEET THE REQUIREMENTS OF THE REF.

2. AN O INDICATES AN OVERAGE, AN S INDICATES A SHORTAGE, AND A B INDICATES A BALANCED MOS. MOS 7202 IS THE FIELD GRADE MOS FOR ALL 7200 MOS. THE STATUS OF MARINE OFFICER MOS IS AS FOLLOWS:

MOS	COMPANY GRADE	MAJOR	LTCOL
0180	S	B	B
0202	S	S	S
0302	O	O	O
0402	B	S	S
0802	O	O	O
1302	B	S	S
1802	O	O	O
1803	O	B	O
2502	B	S	S
3002	S	B	S
3404	S	S	S
3502	S	B	O
4002	B	S	S

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                                                CMC WASHINGTON

4302	S	S	S
5803	S	S	B
6002	B	B	S
6602	B	S	B
7204	O	-	-
7208	S	-	-
7210	S	-	-
7220	B	-	-
7202	-	S	O

3. APPROVAL OF A LATERAL MOVE REQUEST IS SUBJECT TO SCHOOL SEAT AVAILABILITY FOR A PARTICULAR MOS. OFFICERS CONSIDERING A LATERAL MOVE SHOULD CONTACT MMOA-3 TO DETERMINE ELIGIBILITY/SCHOOL SEAT AVAILABILITY PRIOR TO SUBMITTING A WRITTEN REQUEST. OFFICERS SHOULD ALSO CONTACT THE CAREER COUNSELORS (MMOA-4) PRIOR TO SUBMISSION OF A REQUEST TO EVALUATE THE CAREER IMPACT OF A LATERAL MOVE/CAREER BROADENING TOUR. THE POINT OF CONTACT AT HQMC CODE MMOA-3 FOR LATERAL MOVE REQUESTS IS MAJOR LOUIS RACHAL AT DSN 224-5211/2740 OR COMMERCIAL (703) 614-5211/2740.

4. THIS BULLETIN IS NOT APPL TO THE MCR.

5. THIS BULLETIN IS CANCELED 30 APRIL 96.//

BT

*** MDS office codes that have received this message: ***

037   10B   10G

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                             CMC WASHINGTON

APPENDIX C

SAS Code

```
options linesize=80
pagesize=58 ;
data piece;
    length   sex   race   ethnic   class   source   collmaj   married
    mos1   mos2   mos3   $ 4 ;
    infile "piece.unix" delimiter=",";
    input number
        sex $      race $      ethnic $      gct      class $      source $      comprk
        acadrk      leadrk      milsrk   collmaj $   married $      mos1 $      mos2 $
        mos3 $   orb871      orb872      orb881      orb882      orb891      orb892
        orb901   orb902      orb90L      orb911      orb912      orb92      orb93;
    if   class="1-77" or class="1-78" or class="1-79" or class="1-80"  or class="1-81" or
                class="1-82" or class="1-83" or class="1-7T" or class="2-77" or class="2-78"
    or
        class="2-79" or class="2-80" or class="2-81" or class="2-82" or class="2-83" or
        class="3-77" or class="3-78" or class="3-79" or class="3-80" or class="3-81" or
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        class="7-82" or class="7-83" or class="8-78" or class="8-79" or class="8-80" or
        class="8-81" or class="8-82" or class="8-83" then delete;
        drop number;
proc means data=piece noprint;
    class class;  var comprk;
    output out=classmax
    max=topmax;
proc sort data=piece;
    by class;  data piece;
merge piece classmax;
    by class;
    compper = comprk/topmax;
    if comprk=. then delete;
    drop percent;
data piece; set piece;
    if source="A" or source="B" or source="E" or source="X" then res=1;
    if source="C" or source="D" then res=2;
    if mos1="180"  or mos2="180"  or mos3="180" and  (mos1="9901" or mos1="101" or
            mos1="180") then person=1;
    if mos1="202"  or mos2="202"  or mos3="202" and    (mos1="9901" or mos1="201"
    or mos1="202") then intel=1;
```

if mos1="302" or mos2="302" or mos3="302" and (mos1="9901" or mos1="301" or mos1="302") then inftry=1;

if mos1="402" or mos2="402" or mos3="402" and (mos1="9901" or mos1="401" or mos1="402") then log=1;

if mos1="802" or mos2="802" or mos3="802" and (mos1="9901" or mos1="801" or mos1="802") then arty=1;

if mos1="1302" or mos2="1302" or mos3="1302" and (mos1="9901" or mos1="1301" or mos1="1302") then enginner=1;

if mos1="1802" or mos2="1802" or mos3="1802" and (mos1="9901" or mos1="1801" or mos1="1802") then tank=1;

if mos1="1803" or mos2="1803" or mos3="1803" and (mos1="9901" or mos1="1801" or mos1="1803") then aav=1;

if mos1="2502" or mos2="2502" or mos3="2502" and (mos1="9901" or mos1="2501" or mos1="2502") then comm=1;

if mos1="2602" or mos2="2602" or mos3="2602" and (mos1="9901" or mos1="2601" or mos1="2602") then sigint=1;

if mos1="3002" or mos2="3002" or mos3="3002" and (mos1="9901" or mos1="3001" or mos1="3002") then supo=1;

if mos1="3060" or mos2="3060" or mos3="3060" and (mos1="9901" or mos1="3001" or mos1="3060") then avsupo=1;

if mos1="3404" or mos2="3404" or mos3="3404" and (mos1="9901" or mos1="3401" or mos1="3404") then disburs=1;

if mos1="3502" or mos2="3502" or mos3="3502" and (mos1="9901" or mos1="3501" or mos1="3502") then motort=1;

if mos1="4002" or mos2="4002" or mos3="4002" and (mos1="9901" or mos1="4001" or mos1="4002") then data=1;

if mos1="6002" or mos2="6002" or mos3="6002" and (mos1="9901" or mos1="6001" or mos1="6002") then avmaint=1;

if mos1="7204" or mos2="7204" or mos3="7204" and (mos1="9901" or mos1="7201" or mos1="7204") then aaw=1;

if mos1="7208" or mos2="7208" or mos3="7208" and (mos1="9901" or mos1="7201" or mos1="7208") then airsupt=1;

if mos1="7210" or mos2="7210" or mos3="7210" and (mos1="9901" or mos1="7201" or mos1="7210") then airdefn=1;

if res=1 then aug=1;

if orb871=5 or orb872=5 or orb881=5 or orb882=5 or orb891=5 or orb892=5 or orb901=5 or orb902=5 or orb90L=5 or orb911=5 or orb912=5 or orb92=5 or orb93=5 then aug=5;

if orb871=2 or orb872=2 or orb881=2 or orb882=2 or orb891=2 or orb892=2 or orb901=2 or orb902=2 or orb90L=2 or orb911=2 or orb912=2 or orb92=2 or orb93=2 then aug=2;

if airdefn=1 and aug=5 then put compper;

APPENDIX D

UNITED STATES MARINE CORPS
The Basic School
Marine Corps Combat Development Command
Quantico, Virginia 22134-5019

c:\wt_usna
24 Mar 95

From: TBS Testing Officer (S-3)
To: USNA / USMC Liasion

Subj: TBS EVENT WEIGHT DATA SHEET (95-83)

1. Per your request, the data in the table below is taken from the first Basic Officer Class of each year (Alpha Co.) The data has not been correlated (note the 300 point system vs. the 100 point system). N   also that several exam: have changed names over the years, as well as subject areas (academic vs. military skills

Academic Events	95	94	93	92	91	90	89	88	87	86	85	84	83
B0100X ADMIN / PERS. & GEN'L ADMIN			3	3	9	5	5	5	5	5	5	5	5
B0321X ENGR/AVI/NBC	4	4	4										
B0359X DEFENSE	4	4	4	5	15								
B0362X PATROLLING	4	4	4	5	15								
B0398X OFFENSE	4	4	4	5.33	16								
B0391X TACTICS I / COMB. ARMS I						10	10	10	11	11	11	11	11
B0392X TACTICS III / TACTICS II PATRLING / 5 PARA. ORDER						6	9	9	10	10	10	10	10
B0393X TACTICS IV / TACTICS III / PATRLING						9	6	6	6	10	10	10	10
B0394X TACTICS V / COMBINED ARMS IV						10	10	10	10	10	10	10	10
B0395X 5 PARA. ORDER									4				
B0791X BASIC SKILLS I / COMMAND & LDRSHP I	4	4	3	4.33	10	10	10	10	11	11	11	11	6
B0792X LEADERSHIP & ADMINISTRATION / COMMAND & LDRSHP II	4	4	3	4.33	5	7	7	7	6	6	6	6	11
B0793X AMPHIBIOUS OPERATIONS / COMMAND & LDRSHP III	3	3	3	3.33	11	13	10	10	10	10	10	10	10
B0794X COMMAND & LDRSHP IV						7	10	10	10	10	10	10	10
B0859X SUPPORTING ARMS 1	2	4	4	5	15								

Academic Events (cont'd)

Event													
B0860X SUPPORTING ARMS 2	2												
B1470X/1490X LAND NAVIGATION / B1400X MAPPING	1	1	1	1	3	5	5	5	7	7	7	7	7
B2192X TACTICS II / COMB. ARMS II						10	10	10	10	10	10	10	10
B2193X COMB. ARMS III									4	10	10	10	10
B2194X CALL FOR FIRE TEST									6				
B4400X MILITARY LAW	4	4	2	1.68	5	5	7	7	9				
B4401X JAGMAN INV						3	1	1	1				
B4400X MIL. LAW & JAGMAN										10	10	10	10
	36	36	35	38	114	100	100	100	120	120	120	120	120

Leadership Events

Event													
B0795X 1ST COMMAND EVALUATION	12	12	12	13.33	40	40	40	40	45	45	45	45	45
B0796X 2ND COMMAND EVALUATION	20	20	20	20	60	60	60	60	75	75	75	75	75
	32	32	32	33.33	100	100	100	100	120	120	120	120	120

Military Skills Events

Event													
B0101X FITNESS REPORT WRITTEN & PRACT	2	2	1	0.33	1								
B0191X TECHNIQUES OF MILITARY INSTRUCTION	2	2	2	0.67	2	4	4	4	3	3	3	3	3
B0321X TACTICS IV				5	15								
B0368X FIVE PARAGRAPH ORDER / TACTICS VII / B0395X	4	4	4	5	15	8	8	8					
B1460X NIGHT NAV FINAL / 1491X	1	1	1	1	3	5	5	5	2	2	2	2	2
B1485X LAND NAVIGATION FINAL EXERCISE/1495X/90X	3	3	2	2.68	8	10	10	10	10	10	10	10	10
B2194X CALL FOR FIRE TEST						8	8	8					
B2140X WEAPONS PRAC / TACTICS II / B2195X	4	4	4	5	15	10	10	10					
B2291X RIFLE QUALIFICATION	2	2	2	1	3	9	9	9	9	9	9	9	9
B2292X PISTOL QUALIFICATION	2	2	2	0.67	2	8	8	8	8	8	8	8	8
B2500X COMMUNICATIONS (WRITTEN & PRACT)	2	2	2	2.67	8	8	8	8					
B4401 JAG MANUAL INV			2	1	3								
B8400X PFT : INTERMEDIATE									4				
B8400X PFT / B8401X PFT : FINAL	1	1	1	1	3	5	5	10	9	9	9	9	9

Military Skills (cont'd)

B8405X CLOSE COMBAT EVALUATION / B8401X COMBAT COND. CRSE	1	1		0.33	1	5	5						
B8490X SWIM QUALIFICATION	1	1	1	0.33	1	4	0	0	5	5	5	5	5
B8491X CONFIDENCE COURSE			1	0.33	1	2	2	2	1	1	1	1	1
B8492X SINGLE O' COURSE				0.33	1	3	3	3	2	2	2	2	2
B8493X DOUBLE O' COURSE	2	2	2	0.33	1	4	4	4		4	4	4	4
B8494X ENDURANCE COURSE	2	2	2	0.33	1	4	4	4	4	4	4	4	4
B8599X DRILL EVALUATION / B8500X	2	2	2	0.67	2	3	7	7	3	3	3	3	3
B8605X FIRST AID EVALUATION (WRITTEN & PRAC)	1	1	1										
	32	32	32	28.67	86	100	100	100	60	60	60	60	60
TOTAL WEIGHTS	100	100	99	100	300	300	300	300	300	300	300	300	300

2. Should you have any further questions, the point of contact is Capt Strong, at 784-5286 (av 278-).

R. W. STRONG

APPENDIX E

The following are the summary results for the logistic regressions.

1. Conditional Probabilities of augmentation

MOS 0180
Call: glm(formula = ycond0180 ~ xcond, family = binomial)
Deviance Residuals:
     Min   1Q   Median   3Q   Max
 -1.419956 -1.12325 0.8953245 1.15598 1.301048
Coefficients:
             Value   Std.Error   t value
(Intercept) 0.7161099 0.8227413 0.8703950
    xcond -1.0158204 1.1471850 -0.8854896
Residual Deviance: 47.68952 on 33 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9095348

MOS 0202
Call: glm(formula = ycond02 ~ xcond, family = binomial)
Deviance Residuals:
     Min   1Q   Median   3Q   Max
 -2.022298 -0.6023011 0.3052841 0.7082864 1.759811
Coefficients:
             Value Std.Error   t value
(Intercept) 3.499144 1.421209 2.462089
    xcond -5.780583 2.309030 -2.503468
Residual Deviance: 21.72156 on 21 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9268139

MOS 0302
Call: glm(formula = ycond03 ~ xcond, family = binomial)
Deviance Residuals:
     Min   1Q   Median   3Q   Max
 -1.711212 -1.052347 0.7211818 1.04085 1.666879
Coefficients:
             Value Std.Error   t value
(Intercept) 1.248570 0.1704381 7.325654
    xcond -2.385688 0.2998491 -7.956295
Residual Deviance: 796.5882 on 624 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.8677001

MOS 0402
Call: glm(formula = ycond04 ~ xcond, family = binomial)
Deviance Residuals:
        Min   1Q   Median   3Q   Max
    -1.368118 -1.08762 -0.9269959 1.20906 1.478488
Coefficients:
                Value   Std.Error   t value
(Intercept) 0.6417218 0.4614441   1.390682
     xcond -1.3331505 0.7152138 -1.863989
(Residual Deviance: 175.8932 on 128 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9223797

MOS 0802
Call: glm(formula = ycond08 ~ xcond, family = binomial)
Deviance Residuals:
        Min   1Q   Median   3Q   Max
    -1.527186 -0.9475531 -0.7281574 1.109834 1.760644
Coefficients:
                Value   Std.Error   t value
(Intercept) 0.9010336 0.2813221   3.202854
     xcond -2.2824533 0.4707008 -4.849054
Residual Deviance: 332.0022 on 261 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.8842283

MOS 1302
Call: glm(formula = ycond13 ~ xcond, family = binomial)
Deviance Residuals:
        Min   1Q   Median   3Q   Max
    -1.788531 -1.030013 0.5934746 0.9465263 1.648283
Coefficients:
                Value   Std Error   t value
(Intercept) 1.876279 0.5468192   3.431259
     xcond -2.952309 0.8512006 -3.468405
Residual Deviance: 108.4071 on 87 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.906369

MOS 1803
Call: glm(formula = ycond1803 ~ xcond, family = binomial)
Deviance Residuals:
        Min   1Q   Median   3Q   Max
    -1.685794 -1.285351 0.7385314 0.9501441 1.264933
Coefficients:
                Value   Std. Error   t value
(Intercept) 1.345789 0.6654888   2.022256
     xcond -1.643372 1.1811224 -1.391365

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Residual Deviance: 55.65551 on 42 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.8761828

MOS 2502
Call: glm(formula = ycond25 ~ xcond, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
-1.460958 -1.013845 -0.7592373 1.178692 1.708881
Coefficients:
              Value   Std. Error   t value
(Intercept) 0.8486663 0.4025012 2.108482
     xcond -2.0785061 0.6762883 -3.073402
Residual Deviance: 190.7025 on 145 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.903438

MOS 2602
Call: glm(formula = ycond26 ~ xcond, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
-1.731873 -1.078446 0.7008838 1.036945 1.585789
Coefficients:
              Value Std. Error   t value
(Intercept) 1.363727 0.7426323 1.836342
     xcond -2.813106 1.4554125 -1.932858
Residual Deviance: 39.91064 on 30 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.8595044

MOS 3002
Call: glm(formula = ycond30 ~ xcond, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
-1.447024 -1.036768 -0.9034232 1.237409 1.485631
Coefficients:
              Value Std. Error   t value
(Intercept) 0.9379975 0.4461754 2.102307
     xcond -1.6385426 0.6121632 -2.676643
(Residual Deviance: 203.5416 on 151 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9281517

MOS 3060
Call: glm(formula = ycond3060 ~ xcond, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
-1.279126 -1.031567 -0.8539235 1.220945 1.547621

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Coefficients:

	Value	Std. Error	t value
(Intercept)	0.4270451	0.6495008	0.6574975
xcond	-1.3792508	1.0255715	-1.3448607

Residual Deviance: 77.88804 on 57 degrees of freedom
Correlation of Coefficients:(Intercept) xcond -0.9105426

MOS 3402

Call: glm(formula = ycond34 ~ xcond, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.483274	-0.9649072	-0.7548062	1.210329	1.735827

Coefficients:

	Value	Std. Error	t value
(Intercept)	1.052060	0.7159257	1.469510
xcond	-2.455318	1.1506972	-2.133766

Residual Deviance: 74.7487 on 57 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.922296

MOS 3502

Call: glm(formula = ycond35 ~ xcond, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.331474	-1.002569	-0.906423	1.263349	1.475016

Coefficients:

	Value	Std. Error	t value
(Intercept)	0.5063126	0.5910568	0.8566226
xcond	-1.2155233	0.8001168	-1.5191824

Residual Deviance: 148.2748 on 109 degrees of freedom
Correlation of Coefficients:(Intercept)xcond -0.9443201

MOS 4002

Call: glm(formula = ycond40 ~ xcond, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.534592	-0.3233632	-0.165585	0.2980955	2.18482

Coefficients:

	Value	Std. Error	t value
(Intercept)	3.317783	1.233950	2.688750
xcond	-8.107316	2.515523	-3.222915

Residual Deviance: 22.01718 on 35 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.89705

MOS 6002

Call: glm(formula = ycond60 ~ xcond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.750935 -1.019153 0.6444197 1.029916 1.627021
Coefficients:
             Value   Std. Error   t value
(Intercept) 1.639404 0.6492864 2.524932
    xcond -2.749758 1.0854012 -2.533403
Residual Deviance: 85.31115 on 65 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9171616

MOS 7204

Call: glm(formula = ycond7204 ~ xcond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.981038 -0.8981183 0.4666866 0.8598333 1.776403
Coefficients:
             Value   Std. Error   t value
(Intercept) 2.625022 0.8071189 3.252337
    xcond -4.478198 1.3047482 -3.432231
Residual Deviance: 66.17331 on 57 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9291944

MOS 7208

call: glm(formula = ycond7208 ~ xcond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.443314 -0.8320229 -0.4854147 0.8229951 2.10099
Coefficients:
             Value   Std. Error   t value
(Intercept) 1.467134 0.8296655 1.768344
    xcond -4.242553 1.4806016 -2.865425
Residual Deviance: 50.87531 on 48 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9092873

MOS 7210

Call: glm(formula = ycond7210 ~ xcond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-2.022833 -0.8406188 -0.3851453 0.8876418 1.878677
Coefficients:
             Value   Std. Error   t value
(Intercept) 2.495728 0.8936435 2.792756
    xcond -5.248673 1.5861544 -3.309055

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Residual Deviance: 52.17225 on 48 degrees of freedom
Correlation of Coefficients: (Intercept) xcond -0.9249945

2. Probabilities that an officer will attempt to augment

MOS 0180
Call: glm(formula = ytry0180 ~ xtry, familiy = binomial)
Deviance Residuals:
     Min   1Q   Median   3Q   Max
-0.5043047 -0.450723 -0.351099 0.5191483 0.6856914
Coefficients:
            Value   Std. Error t value
(Intercept) 0.3125828 0.1281053 2.440045
     xtry 0.1967452 0.1901773 1.034536
Residual Deviance: 19.61086 on 79 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.9018062

MOS 0202
Call: glm(formula = ytry02 ~ xtry, family = binomial)
Deviance Residuals:
     Min   1Q   Median   3Q   Max
-1.590897 -1.007699 -0.8110161 1.131186 1.586371
Coefficients:
            Value   Std. Error   t value
(Intercept) -0.9819231 0.5585467 -1.757997
     xtry 1.9919987 1.0424309 1.910917
Residual Deviance: 62.51444 on 46 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.8420756

MOS 0302
Call: glm(formula = ytry03 ~ xtry, family = binomial)
Deviance Residuals:
     Min   1Q   Median   3Q   Max
-1.46554 -1.35112 0.9403731 0.9928485 1.043515
Coefficients:
           Value Std. Error   t value
(Intercept) 0.3220422 0.1171779 2.748318
     xtry 0.3338102 0.2102180 1.587924
Residual Deviance: 1346.794 on 1012 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.8342574

MOS 0402
Call: glm(formula = ytry04 ~ xtry, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.243581 -1.170078 -1.053957 1.182829 1.291323
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.3054789 0.2887249 -1.058028
      xtry 0.4597352 0.4480144 1.026162
Residual Deviance: 366.2163 on 263 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.9045147

MOS 0802
Call: glm(formula = ytry08 ~ xtry, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.336779 -1.306373 1.031135 1.051028 1.077779
Coefficients:
                Value   Std. Error   t value
(Intercept) 0.2383851 0.2047986 1.1639978
      xtry 0.1298883 0.3322143 0.3909774
Residual Deviance: 621.2092 on 454 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.886468

MOS 1302
Call: glm(formula = ytry13 ~ xtry, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.30453 -1.199313 1.057553 1.13454 1.230844
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.1335165 0.3128290 -0.4268035
      xtry 0.4274917 0.5121527 0.8346959
Residual Deviance: 234.5943 on 168 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.8706615

MOS 1802
Call: glm(formula = ytry1802 ~ xtry, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.236155 -1.179831 0.007338682 1.173566 1.251573
Coefficients:
                Value   Std. Error   t value
(Intercept) 0.1533550 0.4198041 0.3653014
      xtry -0.3469716 0.8075747 -0.4296464

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Residual Deviance: 113.4911 on 80 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.8500499

MOS 1803
Call: glm(formula = ytry1803 ~ xtry, family = binomial)
Deviance Residuals:
         Min   1Q   Median   3Q   Max
 -1.707534 -1.23134 0.7599539 0.9363852 1.224763
Coefficients:
                Value Std. Error   t value
(Intercept) 1.428776 0.5675353   2.51751
       xtry -1.572452 0.9347539 -1.68221
Residual Deviance: 85.34383 on 66 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.8894731

MOS 2502
Call: glm(formula = ytry25 ~ xtry, family = binomial)
Deviance Residuals:
         Min   1Q   Median   3Q   Max
 -1.234382 -1.218688 1.123591 1.135967 1.146833
Coefficients:
                Value   Std. Error   t value
(Intercept) 0.13588335 0.2732178 0.4973445
       xtry -0.06406816 0.4394580 -0.1457890
Residual Deviance: 387.4409 on 278 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.8989618

MOS 2602
Call: glm(formula = ytry26 ~ xtry, family = binomial)
Deviance Residuals:
         Min   1Q   Median   3Q   Max
 -1.229823 -1.050415 -0.967368 1.287676 1.413716
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.5460762 0.4126693 -1.3232781
       xtry 0.6685020 0.8205654   0.8146845
Residual Deviance: 100.5632 on 72 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.8209858

MOS 3002
Call: glm(formula = ytry30 ~ xtry, family = binomial)
Deviance Residuals:
         Min   1Q   Median   3Q   Max
 -1.330514 -1.22024 1.048393 1.137751 1.172026

Coefficients:

	Value	Std. Error	t value
(Intercept)	0.3772914	0.3362099	1.1221902
xtry	-0.3646026	0.4544953	-0.8022141

Residual Deviance: 397.4811 on 286 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.9361512

MOS 3060

Call: glm(formula = ytry3060 ~ xtry, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.396872	-1.249158	0.9950158	1.08815	1.247081

Coefficients:

	Value	Std. Error	t value
(Intercept)	-0.2329533	0.4486785	-0.5191988
xtry	0.7414938	0.7188108	1.0315563

Residual Deviance: 147.7209 on 106 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.9014743

MOS 3402

Call: glm(formula = ytry34 ~ xtry, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.275497	-1.183951	1.086851	1.154875	1.207959

Coefficients:

	Value	Std. Error	t value
(Intercept)	0.2418496	0.4569201	0.5293040
xtry	-0.3134392	0.6886679	-0.4551384

Residual Deviance: 159.138 on 113 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.91268

MOS 3502

Call: glm(formula = ytry35 ~ xtry, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.355222	-1.255469	1.016119	1.0724	1.250585

Coefficients:

	Value	Std. Error	t value
(Intercept)	-0.2266552	0.4177713	-0.5425342
xtry	0.6354883	0.5732649	1.1085421

Residual Deviance: 275.2139 on 199 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.9402374

MOS 4002
Call: glm(formula = ytry40 ~ xtry, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
  -1.351262 -1.009988 -0.7812025 1.148568 1.646992
Coefficients:
               Value   Std. Error   t value
(Intercept) -1.077608 0.3988152   -2.702023
      xtry   1.485083 0.6674204   2.225109
Residual Deviance: 116.7107 on 88 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.8331058

MOS 6002
Call: glm(formula = ytry60 ~ xtry, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
  -1.695363 -1.24398 0.8087707 1.000546 1.275956
Coefficients:
               Value   Std. Error   t value
(Intercept) -0.269221 0.4295448   -0.6267587
      xtry   1.514777 0.8010144   1.8910736
Residual Deviance: 141.599 on 107 degrees of freedom
Correlation of Coefficients (Intercept) xtry -0.8847452

MOS 7204
Call: glm(formula = ytry7204 ~ xtry, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
  -1.544197 -1.332982 0.8769985 0.9767996 1.108167
Coefficients:
               Value   Std. Error   t value
(Intercept) 0.1092253 0.4621440   0.2363448
      xtry 0.7883216 0.7908885   0.9967544
Residual Deviance: 123.1193 on 92 degrees of freedom
Correlation of Coefficients:(Intercept) xtry -0.8864334

MOS 7208
Call: glm(formula = ytry7208 ~ xtry, family = binomial)
Deviance Residuals:
      Min   1Q   Median   3Q   Max
  -1.218045 -1.202544 1.139124 1.152531 1.161945
Coefficients:
               Value   Std. Error   t value
(Intercept) 0.09889855 0.5133718   0.19264509
      xtry -0.06238654 0.7943472 -0.07853812

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Residual Deviance: 134.3716 on 95 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.9183533

MOS 7210
Call: glm(formula = ytry7210 ~ xtry, family = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -1.161112 -1.076195 -1.041518 1.256582 1.328137
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.03572903 0.4362552 -0.08189938
       xtry -0.31406613 0.6887134 -0.45601858
Residual Deviance: 153.7687 on 110 degrees of freedom
Correlation of Coefficients: (Intercept) xtry -0.8999134

3. Unconditional probabilities of augmentation

MOS 0180
Call: glm(formula = yuncond0180 ~ xuncond, familiy = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -0.2309687 -0.2242149 -0.2196572 -0.2168926 0.7834135
Coefficients:
                Value   Std. Error   t value
(Intercept) 0.23125327 0.1082329 2.13662607
    xuncond -0.01486676 0.1606759 -0.09252636
Residual Deviance: 13.99848 on 79 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.9018062

MOS 0202
Call: glm(formula = yuncond02 ~ xuncond, family = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -0.9460467 -0.8505424 -0.711935 1.438884 1.800888
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.554122 0.5639844 -0.9825131
    xuncond -1.018625 1.1254519 -0.9050805
Residual Deviance: 55.22854 on 46 degrees of freedom
Correlation of Coefficients:(Intercept) xuncond -0.8143057

MOS 0302

Call: glm(formula = yuncond03 ~ xuncond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.107009 -0.9230178 -0.7309268 1.30904 1.819176
Coefficients:
               Value   Std. Error   t value
(Intercept) -0.1623329 0.1188071   -1.366357
   xuncond -1.2990529 0.2267526   -5.728943
Residual Deviance: 1239.561 on 1012 degrees of freedom
Correlation of Coefficients:(Intercept) xuncond -0.8179063

MOS 0402

Call: glm(formula = yuncond04 ~ xuncond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-0.8015848 -0.7371435 -0.6891431 -0.659705 1.810071
Coefficients:
               Value   Std. Error   t value
(Intercept) -0.9665458 0.3321453   -2.9100087
   xuncond -0.4578702 0.5287765   -0.8659049
Residual Deviance: 282.7556 on 263 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8970639

MOS 0802

Call: glm(formula = yuncond08 ~ xuncond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.047145 -0.7847568 -0.6187019 -0.5197269 2.015836
Coefficients:
               Value   Std. Error   t value
(Intercept) -0.3036149 0.2203761   -1.377712
   xuncond -1.6379434 0.3933862   -4.163703
Residual Deviance: 486.0296 on 454 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8630558

MOS 1302

Call: glm(formula = yuncond13 ~ xuncond, family = binomial)
Deviance Residuals:
    Min   1Q   Median   3Q   Max
-1.08051 -0.8676868 -0.6932581 1.324885 1.868397
Coefficients:
               Value   Std. Error   t value
(Intercept) -0.2255391 0.3294869   -0.6845161
   xuncond -1.3347424 0.5805266   -2.2991926

Residual Deviance: 198.7359 on 168 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8530269

MOS 1802
Call: glm(formula = yuncond1802 ~ xuncond, family = binomial)
Deviance Residuals:
```
      Min         1Q       Median        3Q        Max
-1.051551 -0.8479266 -0.633191 1.30065 1.916066
```
Coefficients:
```
                Value    Std. Error    t value
(Intercept) -0.2173764  0.4538387 -0.4789729
   xuncond  -1.9227579  0.9934181 -1.9354971
```
Residual Deviance: 91.34271 on 80 degrees of freedom
Correlation of Coefficients:(Intercept) xuncond -0.8276461

MOS 1803
Call: glm(formula = yuncond1803 ~ xuncond, family = binomial)
Deviance Residuals:
```
      Min        1Q        Median       3Q       Max
-1.338271 -1.013557 -0.7172787 1.251638 1.73213
```
Coefficients:
```
                Value   Std. Error    t value
(Intercept)  0.6121146  0.5168982  1.184207
   xuncond  -1.9728354  0.9422784 -2.093686
```
Residual Deviance: 87.40627 on 66 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.869638

MOS 2502
Call: glm(formula = yuncond25 ~ xuncond, family = binomial)
Deviance Residuals:
```
       Min         1Q       Median         3Q         Max
-0.9546878 -0.7584293 -0.624871 -0.5381409 2.010809
```
Coefficients:
```
                Value    Std. Error     t value
(Intercept) -0.4853291  0.3054975 -1.588652
   xuncond  -1.4174264  0.5339476 -2.654617
```
Residual Deviance: 291.4001 on 278 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8810915

MOS 2602
Call: glm(formula = yuncond26 ~ xuncond, family = binomial)
Deviance Residuals:
```
       Min         1Q       Median        3Q        Max
-0.8562856 -0.7878121 -0.6631555 -0.5455787 1.916765
```

Coefficients:

	Value	Std. Error	t value
(Intercept)	-0.8049027	0.4604183	-1.748199
xuncond	-1.0563385	1.0149046	-1.040825

Residual Deviance: 78.64031 on 72 degrees of freedom
Correlation of Coefficients:(Intercept) xuncond -0.7975844

MOS 3002

Call: glm(formula = yuncond30 ~ xuncond, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.067209	-0.7722624	-0.641841	-0.6005417	1.898316

Coefficients:

	Value	Std. Error	t value
(Intercept)	-0.1679421	0.3596237	-0.4669938
xuncond	-1.4535343	0.5154025	-2.8201924

Residual Deviance: 311.4988 on 286 degrees of freedom
Correlation of Coefficients:(Intercept) xuncond -0.9221819

MOS 3060

Call: glm(formula = yuncond3060 ~ xuncond, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.8009657	-0.7287272	-0.6771369	-0.6413487	1.822826

Coefficients:

	Value	Std. Error	t value
(Intercept)	-0.9483029	0.5177969	-1.8314188
xuncond	-0.5477734	0.8493303	-0.6449474

Residual Deviance: 114.0026 on 106 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8944917

MOS 3402

Call: glm(formula = yuncond34 ~ xuncond, family = binomial)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.9856643	-0.7217777	-0.5704566	-0.507372	2.037373

Coefficients:

	Value	Std. Error	t value
(Intercept)	-0.3948881	0.5077782	-0.7776783
xuncond	-1.6451626	0.8370416	-1.9654489

Residual Deviance: 113.9296 on 113 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8893072

MOS 3502

Call: glm(formula = yuncond35 ~ xuncond, family = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -0.8147943 -0.7341005 -0.6914387 -0.6708311 1.783975
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.8699574 0.4791424 -1.8156552
   xuncond -0.5070534 0.6677473 -0.7593492
Residual Deviance: 215.6604 on 199 degrees of freedom
Correlation of Coefficients:(Intercept) xuncond -0.9365812

MOS 4002

Call: glm(formula = yuncond40 ~ xuncond, family = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -0.8924054 -0.6210719 -0.3705064 -0.2413962 2.391395
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.701816 0.4333704 -1.619437
   xuncond -3.033785 1.1639602 -2.606434
Residual Deviance: 65.50372 on 88 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.6859846

MOS 6002

Call: glm(formula = yuncond60 ~ xuncond, family = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -1.030525 -0.9229697 -0.8112624 1.417545 1.6793
Coefficients:
                Value   Std. Error   t value
(Intercept) -0.2745191 0.4373644 -0.6276668
   xuncond -0.8866418 0.8087807 -1.0962697
Residual Deviance: 137.0727 on 107 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.883613

MOS 7204

Call: glm(formula = yuncond7204 ~ xuncond, family = binomial)
Deviance Residuals:
       Min   1Q   Median   3Q   Max
 -1.316646 -0.8940211 -0.670933 1.167246 1.858336
Coefficients:
               Value   Std. Error   t value
(Intercept) 0.378172 0.4732770 0.799050
   xuncond -2.152519 0.8628801 -2.494575

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Residual Deviance: 112.5532 on 92 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8771396

MOS 7208
call: glm(formula = yuncond7208 ~ xuncond, family = binomial)
Deviance Residuals:
         Min   1Q   Median   3Q   Max
     -1.080382 -0.6108114 -0.4331052 -0.3232442 2.350678
Coefficients:
                    Value   Std. Error   t value
(Intercept) -0.03840421 0.6134971 -0.06259885
    xuncond -3.17118914 1.1700566 -2.71028705
Residual Deviance: 75.48542 on 95 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8781126

MOS 7210
Call: glm(formula = yuncond7210 ~ xuncond, family = binomial)
Deviance Residuals:
         Min   1Q   Median   3Q   Max
     -1.172273 -0.6419201 -0.4628368 -0.3485085 2.172368
Coefficients:
                    Value   Std. Error   t value
(Intercept)   0.01360016 0.4909728 0.02770043
    xuncond -2.93062165 0.9467559 -3.09543536
Residual Deviance: 97.47514 on 110 degrees of freedom
Correlation of Coefficients: (Intercept) xuncond -0.8547837

APPENDIX F

Conditional probabilities of augmentation

composite lineal rank percentage

composite lineal rank percentage
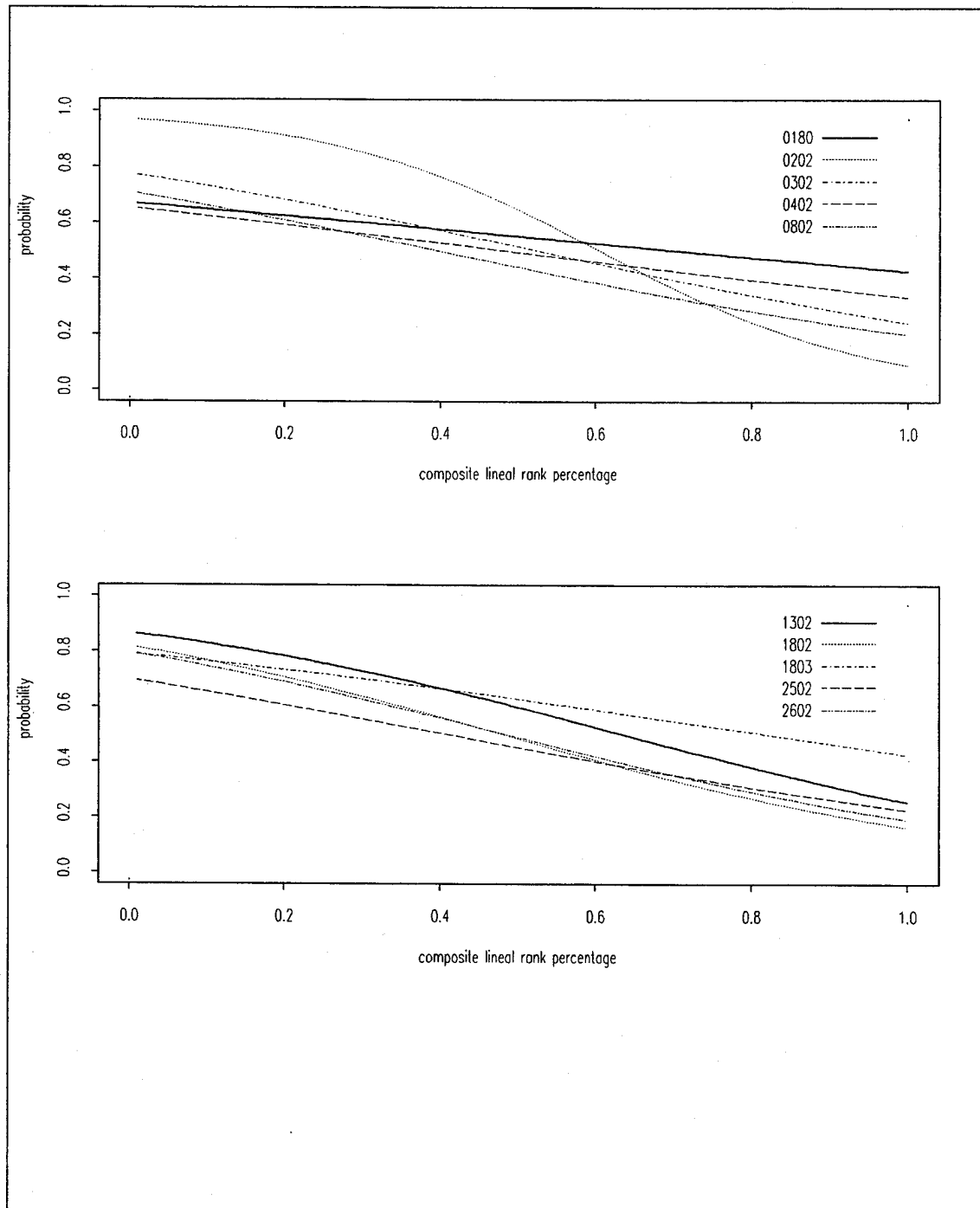
Conditional probabilities of augmentation
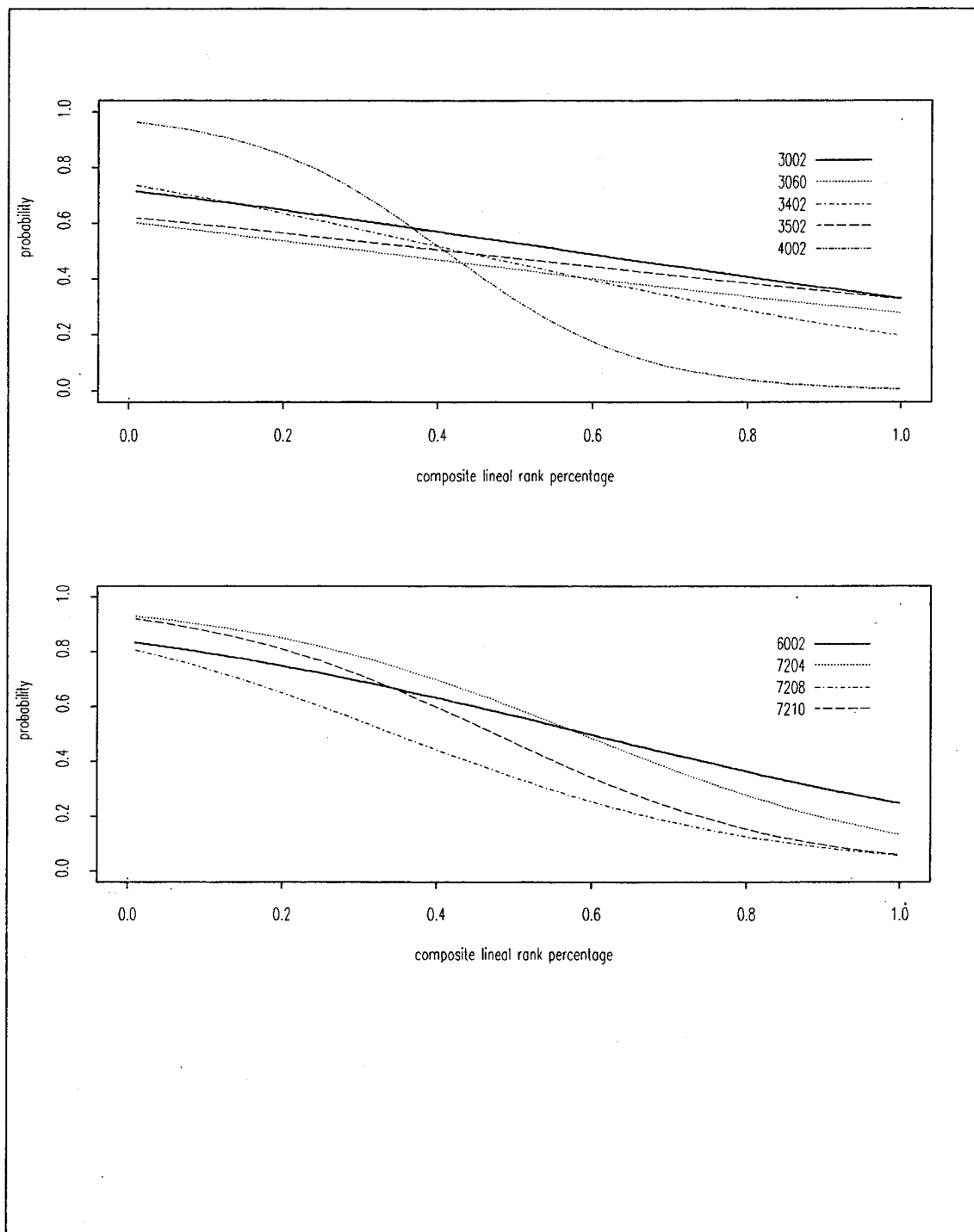
APPENDIX G

Probabilities of attempted augmentation
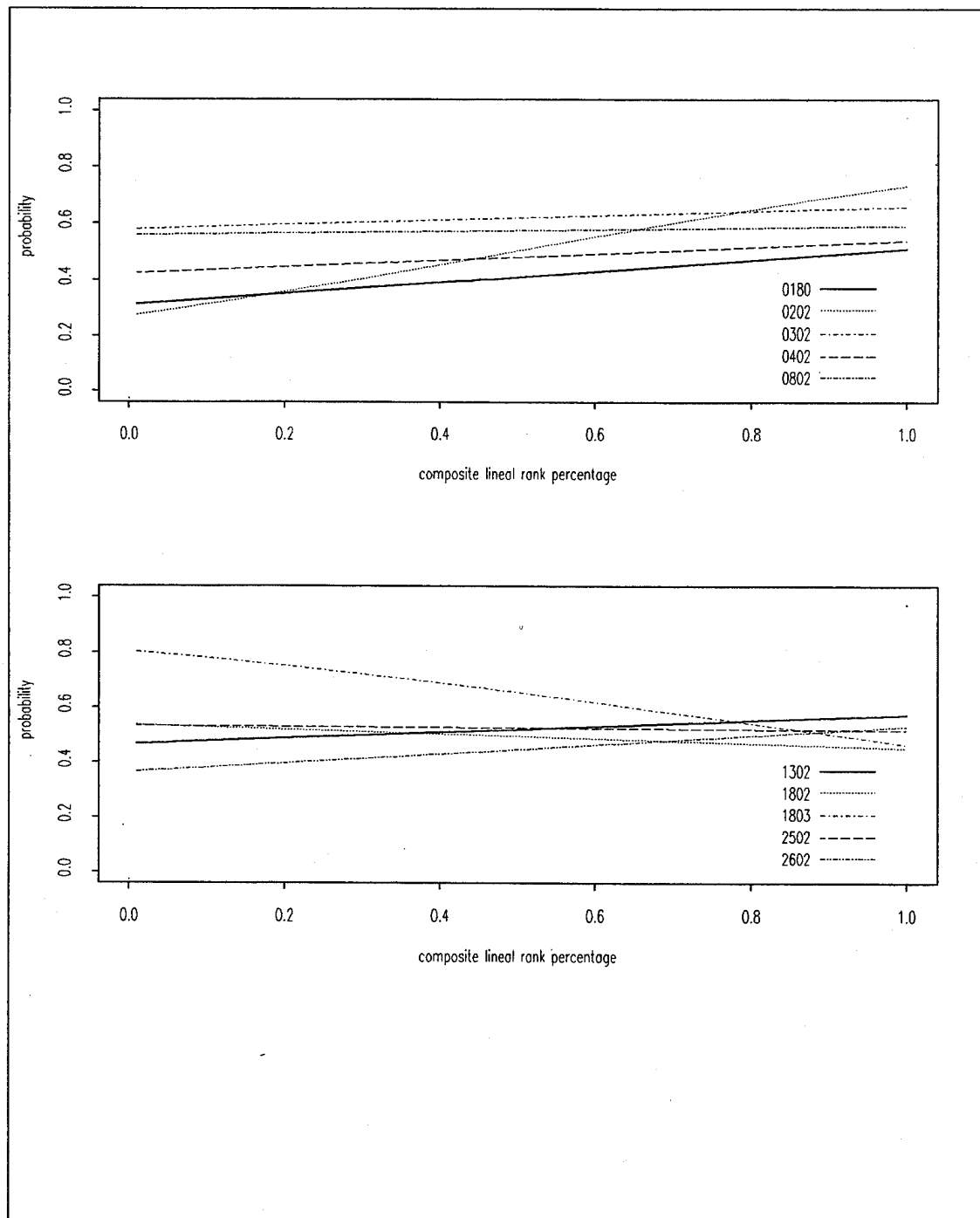
Probabilities of attempted augmentation
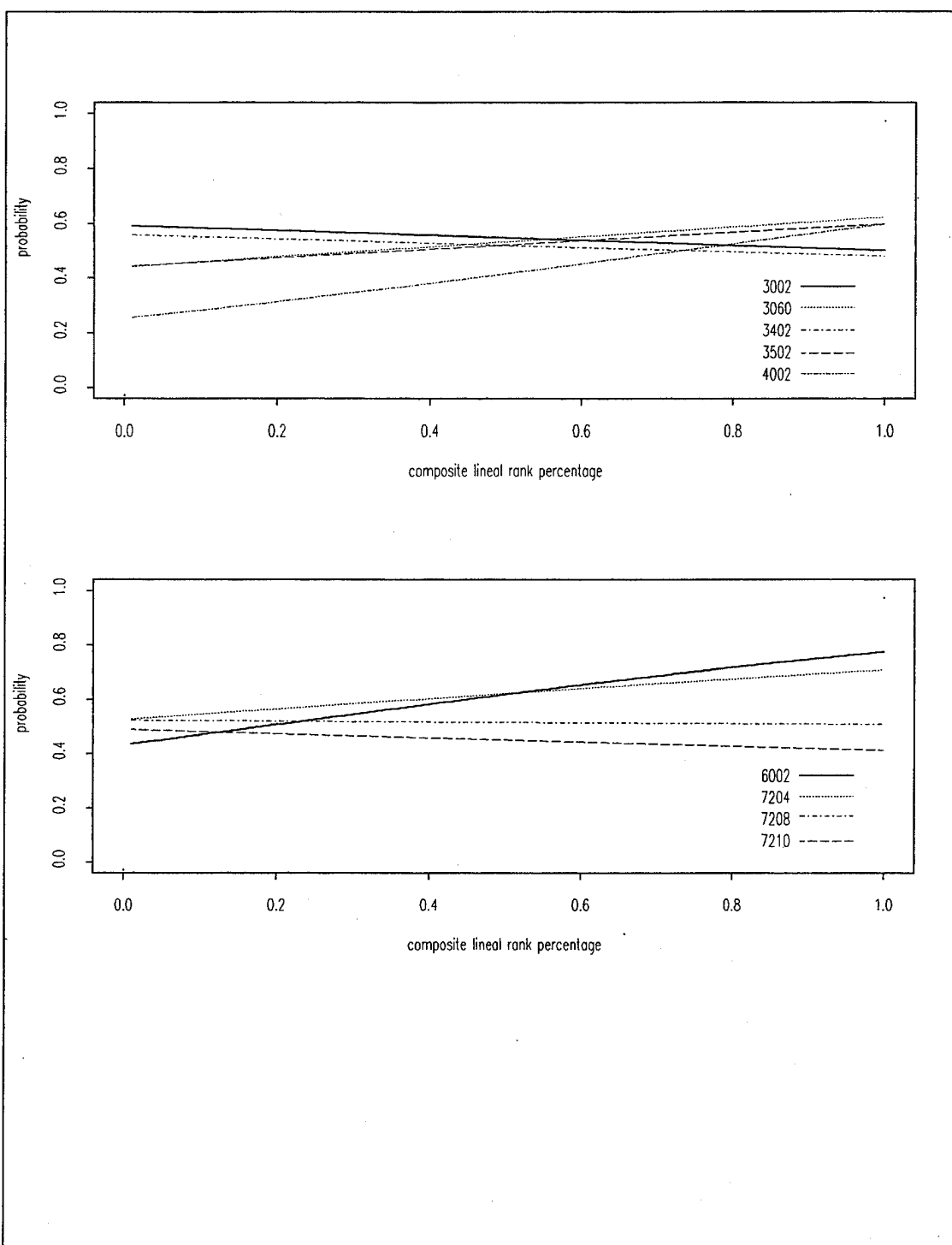
APPENIDIX H

Unconditional probabilites of augmentation

Unconditional probabilities of augmentation
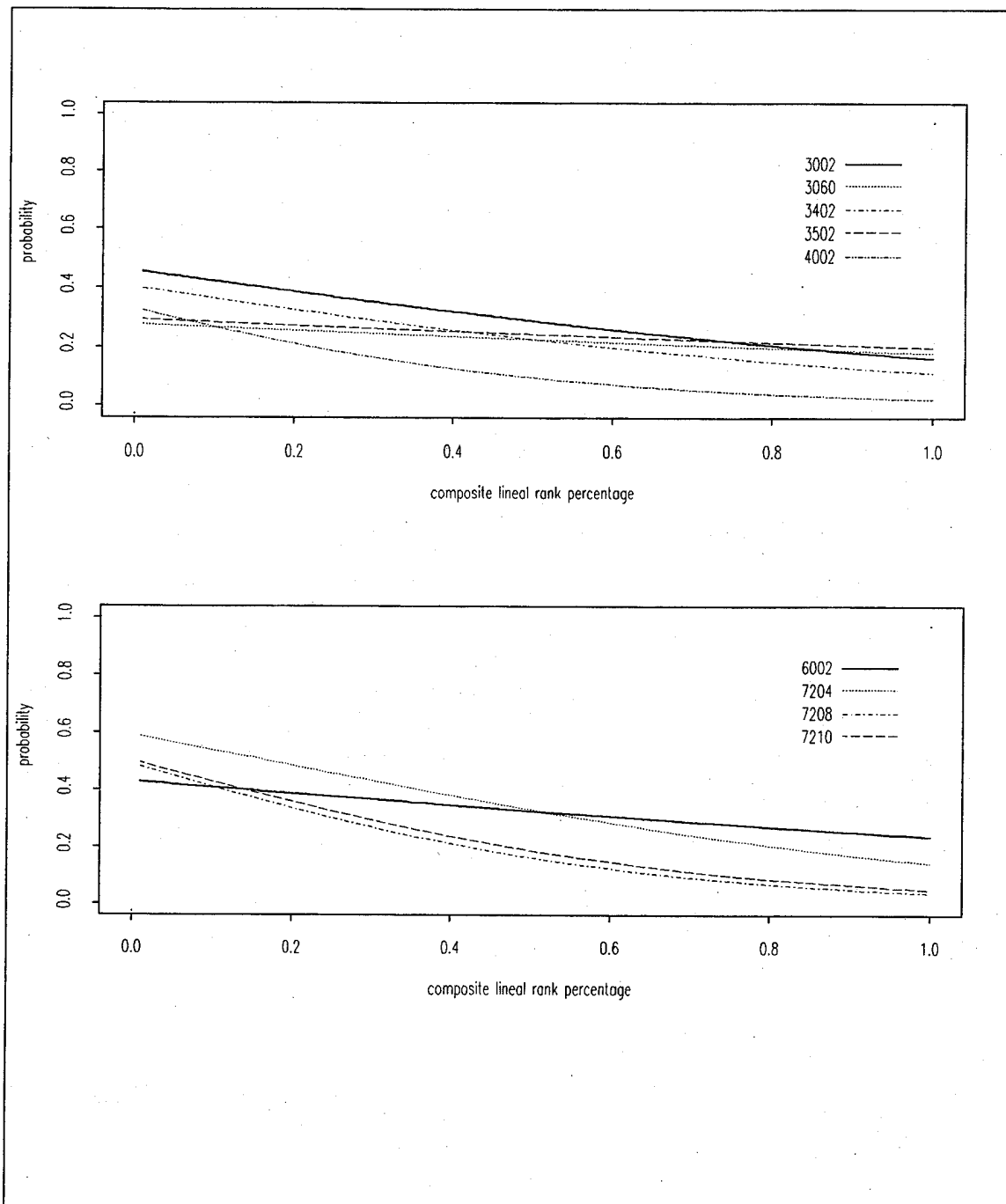
```
Program Choicepoints;
 {This program creates table "A" of "choice points". This simulates each student choosing
   their top three choices. This table is then written in a format which is read by the GAMS
   model which assigns the MOSs}
Type PointType = array [1..250,1..7] of integer;
Type TableType = array [1..250, 1..19] of integer;
Type MosType = array [1..250,1..3] of integer;
GroupType = array [1..3] of integer;
Var  Number: Integer;          {Number of students in the class}
      Rgroup,rmos,count1,count2,count3: Integer;
      Group: Grouptype;
      Points: PointType;
      MOS: Mostype;
      i,j,k:integer;
      outfile2:text;
Begin
    Randomize;
    Assign(outfile2,'a:disa30.dat');
    rewrite(outfile);
    rewrite(outfile2);
    {Writeln ('How many students are in the class');
     Readln (Number);}
    Number:=100;    {100 students used in thesis }
    For i:= 1 to Number do begin
        For j:=1 to 3 do begin
              Rgroup:=Random(100);
              Case Rgroup of
                  0..44: Begin
                              Group[j]:=1;          {makes first two choices from}
                              If j=1 then begin    {from the same group}
                                j:=2;
                                Group[2]:=1;
                              end;
                              if j=3 then begin
                                 if (Group[1]=1) and (Group[2]=1) then begin
                                     j:=2;
                                 end;            {this ensures at least  one}
                              end;                {non-combat arms mos  }
                        end;
                  45..64: Begin
                              Group[j]:=5;
                              If j=1 then begin
                                j:=2;
```

```
                        Group[2]:=5;
                    end;
                end;
        65..70: Begin
                    Group[j]:=4;
                    If j=1 then begin
                        j:=2;
                        Group[2]:=4;
                    end;
                end;
        71..78: Begin
                    Group[j]:=3;
                    If j=1 then begin
                        j:=2;
                        Group[2]:=3;
                    end;
                end;
        79..99: Begin
                    Group[j]:=2;
                    If j=1 then begin
                        j:=2;
                        Group[2]:=2;
                    end;
                end;
    end
end;
for k:=1 to 3 do begin
    case Group[k] of
        1: begin
                rmos:=random(100);
                case rmos of
                    0..59:MOS[i,k]:=0302;
                    60..90:MOS[i,k]:=0802;
                    91..95:MOS[i,k]:=1802;
                    96..99:MOS[i,k]:=1803;
                end
            end;
        2: begin
                rmos:=random(100);
                case rmos of
                    0..23:MOS[i,k]:=3502;
                    24..64:MOS[i,k]:=2502;
                    65..75:MOS[i,k]:=2602;
                    76..99:MOS[i,k]:=1302;
                end
```

```
                end;
          3: begin
                  rmos:=random(100);
                  case rmos of
                        0..14:MOS[i,k]:=0180;
                      15..44:MOS[i,k]:=4002;
                      45..65:MOS[i,k]:=0202;
                      66..99:MOS[i,k]:=3402;
                  end
              end;
          4: begin
                  rmos:=random(100);
                  case rmos of
                        0..29:MOS[i,k]:=7204;
                      30..62:MOS[i,k]:=7208;
                      63..99:MOS[i,k]:=7210;
                  end
              end;
          5: begin
                  rmos:=random(100);
                  case rmos of
                        0..38:MOS[i,k]:=0402;
                      39..77:MOS[i,k]:=3002;
                      78..86:MOS[i,k]:=3060;
                      87..99:MOS[i,k]:=6002;
                  end
              end;
        end;
        if k=2 then begin                          {ensure different choices}
            if MOS[i,2]=MOS[i,1] then k:=k-1;
        end;
        if k=3 then begin
            if (MOS[i,3]=MOS[i,1]) or (MOS[i,3]=MOS[i,2]) then k:=k-1;
        end;
      end;
    end;
    for i:=1 to number do begin                   {assigns points}
        for j:=1 to 3 do begin                     {first choice 3}
            writeln(outfile2,mos[i,j],'.',i,' ',4-j);   {second choice 2}
        end;                                        {third choice 1 }
    end;
    close(outfile2);
end.
```

APPENDIX J

$OFFLISTING OPTION LIMROW=0, LIMCOL=0, ITERLIM=30000, SOLPRINT=OFF;
SETS M mos   / 180,202,302,402,802,1302,1802,
                       1803,2502,2602,3002,3060,3402,3502,
                       4002,6002,7204,7208,7210/
P ranked students   / 1*100 /
PER percentile   / 1*100 /
PREF preference   / THIRD, SECOND, FIRST/
PARAMETERS
  REQD (M) required number of mos M   /   180 1
                                                 202 2
                                                 302 27
                                                 402 8
                                                 802 14
                                                1302 5
                                                1802 2
                                                1803 2
                                                2502 9
                                                2602 2
                                                3002 8
                                                3060 2
                                                3402 3
                                                3502 5
                                                4002 2
                                                6002 2
                                                7204 2
                                                7208 2
                                                7210 2 /
  AUG (M) desired percentage of mos M augmenting   / 180 .20
                                                         202 .20
                                                         302 .20
                                                         402 .20
                                                         802 .20
                                                        1302 .20
                                                        1802 .20
                                                        1803 .20
                                                        2502 .20
                                                        2602 .20
                                                        3002 .20
                                                        3060 .20
                                                        3402 .20
                                                        3502 .20

```
                                    4002  .20
                                    6002  .20
                                    7204  .20
                                    7208  .20
                                    7210  .20 /
   PHAT(M,PER) prob of ind in percentile per aug if assigned mos m
       /
$INCLUDE "AUGPROB3.DAT"
       /
   CP(M,P) choice points (3-most desired) for mos m for ind p
       /
$INCLUDE "a:DISA18.DAT"
       /;
SCALAR AUGMULT wt for augment multiplier for obj function /1/;
SCALAR CHOMULT wt for choice points for obj function /1/;
SCALAR LINMULT wt for lineal ranking for choice points /1/;
VARIABLES
   COUNT(PREF)  number of individuals recieving pref choice
   EXPAUG(M)    expected number of augmentees from mos m
   X(M,P)       binary variable 1 if person p assigned mos m
   Z            total choice points;
BINARY VARIABLE X;
EQUATIONS
   CHOICE       defines objective function
   TOTMOS(M)    total mos requirement
   SINGLE(P)    single mos assignment requirement
   AUGMENT(M)   min acceptable augmentations requirement;

CHOICE..     Z =E= CHOMULT*SUM((M,P), CP(M,P)*X(M,P)*LINMULT*((CARD(P)+1)
               -ORD(P))) + AUGMULT*SUM((M,P),X(M,P)*
               SUM(PER$(ORD(PER) EQ ROUND((ORD(P)/CARD(P))*100)),
               PHAT(M,PER)));
TOTMOS(M)..  SUM(P,X(M,P)) =E= REQD(M);
SINGLE(P)..  SUM(M,X(M,P)) =E= 1;
AUGMENT(M).. SUM(P,X(M,P)*SUM(PER$(ORD(PER) EQ
               ROUND((ORD(P)/CARD(P))*100)),PHAT(M,PER))) =G=
               REQD(M)*AUG(M);
MODEL MOSCA18 /ALL/;
SOLVE MOSCA18 USING MIP MAXIMIZING Z;
FILE RES /RSLTCA18.DAT/;
PUT RES;
RES.PC=5;
LOOP(M,PUT M.TL);
PUT /;
LOOP(P,
```

```
    PUT P.TL;
    LOOP(M,
            PUT X.L(M,P);
    );
    PUT /;
);
FILE AUGRES /EXPCA18.DAT/;
PUT AUGRES;
AUGRES.PC=5;
*puts expected number of augmentees
LOOP(M,
        PUT SUM(P,X.L(M,P)*SUM(PER$(ORD(PER) EQ
        ROUND((ORD(P)/CARD(P))*100)), PHAT(M,PER)));
      PUT /;
);
*puts number of individuals recieves pref choice
LOOP(PREF,
          PUT SUM((M,P)$(CP(M,P) EQ ORD(PREF)),X.L(M,P));
      PUT/;
);
```

```
$OFFLISTING OPTION LIMROW=0, LIMCOL=0, ITERLIM=50000, SOLPRINT=OFF;
SETS  M mos            / 180,202,302,402,802,1302,1802,
                         1803,2502,2602,3002,3060,3402,
                         3502, 4002,6002,7204,7208,7210/
       P ranked students  / 1*100 /
       PER percentile    / 1*100 /
       PREF preference   / THIRD, SECOND, FIRST/
       D division        / 1ST, 2ND, 3RD/
PARAMETERS
  REQD (M)  required number of mos M      / 180  1
                                            202  2
                                            302 27
                                            402  8
                                            802 14
                                            1302  5
                                            1802  2
                                            1803  2
                                            2502  9
                                            2602  2
                                            3002  8
                                            3060  2
                                            3402  3
                                            3502  5
                                            4002  2
                                            6002  2
                                            7204  2
                                            7208  2
                                            7210  2  /
  PHAT(M,PER) prob of ind in percentile per aug if assigned mos m
                   /
$INCLUDE "AUGPROB3.DAT"
              /
  CP(M,P) choice points (3-most desired) for mos m for ind p
              /
$INCLUDE "a:DISA1.DAT"
             /;
VARIABLES    X(M,P)    binary variable 1 if person p assigned mos m
             Z         total choice points;
BINARY VARIABLE X;
EQUATIONS
CHOICE           defines objective function
TOTMOS(M)        total mos requirement
```

```
SINGLE(P)        single mos assignment requirement
QUALITY(M,D)   quality spread requirement;
CHOICE..         Z =E= SUM((M,P), CP(M,P)*X(M,P)*((CARD(P)+1)-ORD(P)));
TOTMOS(M)..      SUM(P,X(M,P)) =E= REQD(M);
SINGLE(P)..      SUM(M,X(M,P)) =E= 1; QUALITY(M,D)..  SUM(P$(((ORD(P)/CARD(P))
                 GE ((ORD(D)-1)/CARD(D))) AND  ((ORD(P)/CARD(P)) LE
                 (ORD(D)/CARD(D)))), X(M,P)) =L= TRUNC (REQD(M)/CARD(D)+.9);
MODEL NMOS3A1  /ALL/;
SOLVE NMOS3A1 USING MIP MAXIMIZING Z;
FILE RES /NRSLT3A1.DAT/;
PUT RES; RES.PC=5;
LOOP(M,PUT M.TL);
PUT /; LOOP(P,
             PUT P.TL;
            LOOP(M,
                  PUT X.L(M,P);
               );
        PUT /;
);
FILE AUGRES /NEXP3A1.DAT/;
PUT AUGRES;
AUGRES.PC=5;
*puts expected number of augmentees
LOOP(M,
       PUT SUM(P,X.L(M,P)*SUM(PER$(ORD(PER) EQ
               ROUND((ORD(P)/CARD(P))*100)), PHAT(M,PER)));
       PUT /;
);
*puts number of individuals recieves pref choice
LOOP(PREF,
       PUT SUM((M,P)$(CP(M,P) EQ ORD(PREF)),X.L(M,P));
       PUT/;
);
```

LIST OF REFERENCES

1 Estes, Kenneth W., The Marine Officer's Guide, Naval Institute Press, 1985

2 text from Information paper 1000 MMOA-3 dtd 3 May 94
  Subj: TBS MOS DISTRIBUTION

3 text from CG, MCCDC Comment on MMOA-3 r/s of 16 Aug 89 1500 TE33P dtd
  2 Oct 89, Subj: MOS ASSIGNMENTS FOR LIEUTENANTS AT TBS

4 text from Position Paper 1500 MMOA-3 undated
  Subj: MOS QUALITY SPREAD POLICY AT THE BASIC SCHOOL

5 discussion with James North, CNA analyst. Report not yet released.

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